PB-230 471

REMOTE SENSING STUDY, WHITEWOOD CREEK/ BELLE FOURCHE RIVER, SOUTH DAKOTA

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National Field Investigations Center-Denver
Denver, Colorado

January 1972

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January 1972

Prepared By:
Denver Field Investigations Center
Office of Enforcement
U. S. Environmental Protection Agency
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INTRODUCTION

An aerial remote sensing program was conducted in late November, 1971, over the following areas:

(a) Whitewood Creek - From Lead, South Dakota, to its point of confluence with the Belle Fourche River.

(b) Belle Fourche and Cheyenne Rivers - From a point on the Belle Fourche River approximately two miles upstream of the mouth of Whitewood Creek downstream to a point on the Cheyenne River approximately ten miles from Oahe Reservoir.

This is sketched in Figure 1.

BACKGROUND

A conference was held on October 19-21, 1971, to present data on metals pollution of western South Dakota streams. One of the subjects considered during the conference was the deposition of previously-discharged Homestake Mining Company tailings solids along Whitewood Creek and the Belle Fourche and Cheyenne Rivers. Recommendation No. 6, adopted by the conferees, stated:

> "The location and composition of buried tailings materials, including abandoned tailings piles, along Whitewood Creek, the Belle Fourche River, and the

Cheyenne River shall be ascertained and documented and the rates of release of heavy metals and toxic elements be established by the State of South Dakota and the Environmental Protection Agency by October 1, 1972, and findings reported to the chairman and the conferees. South Dakota will provide the chairman of this group."

Following the conference, the Region VIII office of E.P.A. requested DFIC to obtain remote-sensing data to assist in meeting this requirement.

MISSION PURPOSE

The expressed purpose of this aerial reconnaissance program was to fulfill the following objectives:

(a) Document the present courses of the respective waterways; and

(b) Locate, to the extent possible, all mine tailing deposits in the target area, for subsequent field verification and sampling. No ground-truth data were requested.

CHRONOLOGICAL DATA

The chronological details of the flight program are given:

(a) 20 November 1971 - Time over target of 10:00-11:15 hours MST in which the areas discussed in sub-paragraphs (a) and (b) of the introduction were covered.
Flight Altitude - 9,500 feet MSL (barometric altitude, mean sea level).

(b) 23 November 1971 - Time over target of 9:30-10:45 hours MST in which Whitewood Creek and the Belle Fourche River from Whitewood Creek's mouth to a point near Hereford, South Dakota (point where the general direction of the river changes from southeasterly to an easterly direction). This mission was necessary due to adverse weather conditions in certain sections of the target area resulting in target misses on the first day.

Flight Altitudes - 9,500 feet MSL and 17,000 feet MSL.

AIRCRAFT SENSOR DATA

The reconnaissance data were recorded aboard two high performance aircraft. Each aircraft contained three framing cameras, an infrared line scanner (IRLS), and a side-looking radar (SLR). All cameras were mounted in their respective vertical positions coincident with the nadir of the aircraft. Each of the cameras, in each aircraft, was uploaded with different recording film/optical filter combinations. They were capable of recording the presence of optical energy within the following bands of the optical spectrum:

(a) Near ultraviolet resulting in a 4.5" X 4.5" negative. (Kodak 2475 Recording Film with a Wratten 47B gelatin optical filter)

(b) Visible region of the optical spectrum resulting in a true-color 4.5" x 4.5" positive aerographic ektachrome transparency. (Kodak SØ -397 Aerographic Ektachrome Film with a Wratten HF-3/HF-5 optical filter combination.)

(c) Near infrared region of the optical spectrum overlapped with a portion of the visible spectrum resulting in an aerographic ektachrome 4.5" X 4.5" false color (rendition) transparency. (Kodak 3443 Aerographic Ektachrome Film with a Wratten 16 gelatin optical filter.)

The IRLS is a cryogenic device (optical and electronic) capable of detecting passive electromagnetic energy resulting from target thermal emissions in the infrared band from 8 to 14 microns (1 micron equals 10^{-6} meters).

The SLR is a peculiar radar that transmits microwave energy, at a particular frequency and polarization, through an antenna which is directed out the sides of the aircraft. The energy is reflected from the illuminated terrain back toward the aircraft where it is taken by the antenna and directed by a microwave network into the radar receiver. The receiver extracts the data, returned from the target terrain by the reflected microwave energy, and directs it to a display/recorder. At this point, the "microwave picture" is directly recorded on an instrumentation film.

The true color photographic technique served as the basis for the recording of the presence of mine tailings. It also provided correct color renditions of targets in question and was extensively used in target location and in area identifications for the interpretation of the ultraviolet and near infrared films.

The ultraviolet and near infrared photographic media, IRLS and

the SLR provided further refinements in the positive detection, location, and identification of the mine tailings located in the river's banks and various meanders. An example of this is the ability to distinguish between river aluvium and oxidized tailings, since in true color only, they are approximately the same color. The fresh (dark gray) tailings concentrations were quite easy to identify.

DESCRIPTION OF DATA REDUCTIONS

As a result of the interpretation of the airborne reconnaissance data, the mine tailing deposits (on-land static concentrations) have been reported on map overlays. The maps used for these overlays were the applicable USGS 7.5 minute quad maps. The overlay can be placed over the appropriate quad map yielding:

(a) Present river course.

(b) Deviation from old river course.

(c) The location of mine tailing deposits depected by the shaded areas.

The overlays are provided as an attachment to this report.

In some cases, large deposits of oxidized tailings have been indicated on the overlays. This suggests that, in the absence of new (gray) tailings deposits, the river's waters have not been in that area for an extended period of time. Such areas represent filled stream channels, and as such represent probable areas of major tailings deposits.

The respective quad maps, used for the overlays, are given in Appendixes 1 and 2, along with the frame counts from the SØ-397 true color films. One column, in each appendix, is labeled "High Altitude" and the others are labeled "Low Altitude 1 and 2". From the discussion under chronological data, high altitude is 17,000 feet MSL and low altitude is 9,500 feet MSL.

There were no overlays made for the first two quads of Appendix 1, namely Lead, South Dakota, and Deadwood, South Dakota. There were neither significant course changes nor tailing concentrations in the Whitewood Creek basin in this particular area.

Attention is directed to the mouth of Whitewood Creek on the Newell quad map. The dispersion of the creek's outflow into the Belle Fourche River is shown. Likewise, in the overlay relating to the Dalzell NE quad, the dispersion of the Belle Fourche waters into the Cheyenne River is shown (refer to attached overlays).

In several instances, a lack of imagery was indicated on the respective quad map overlays. This was due to the aircraft missing extreme reaches of the Belle Fourche River in the photographic endeavor. All such instances occurred downstream from the Hereford SE, South Dakota, quad map. The total river area missed is less than four percent of the total river covered.

On all overlays made for Whitewood Creek and the Belle Fourche River, each shaded area was assigned a number and the area was calculated. These numbers and corresponding areas are given in Appendixes 3 and 4. For Whitewood Creek, the shaded area totaled to 199 acres and for the Belle Fourche River 2,456 acres.

The accuracy of the position of each line drawn on the overlays is plus or minus 50 feet.

APPENDIX 1

WHITEWOOD CREEK IMAGERY FRAME DATA

USGS Quad	High Altitude	Low Altitude	
		Roll #1	Roll #2
Lead	Beginning to 3314	Beginning to 2656	Beginning to 0490
Deadwood South	3314 to 3311	2656 to 2665	0490 to 0506
Deadwood North	3311 to 3302	2665 to 2709	0506 to 0558
Sturgis	3302 to 3298	2709 to 2723	OUT
St. Onge Southeast	3298 to 3288	2723 to 2759	OUT
Newell	3287 to 3286	2767 to 2777	OUT

APPENDIX 2

BELLE FOURCHE RIVER IMAGERY FRAME DATA

USGS Quad	High Altitude	Low Altitude Roll #1	Low Altitude Roll #2
Newell	3287-3283	2767-2777	
Vale Northeast	3283-3270	2777-2793	
Vale Southeast	3270-3270		
Volunteer	3270-3259	2794-2819	
Volunteer Southeast	3259-3259	2819-2821	Beginning to 0553
Rapid City	3259-3250	2820-2848	0552-0575
Hereford	3250-3247	2848-2857	0576-0591
Hereford Southwest	3247-3242	2857-2871	1591-0603
Hereford Southeast	180° & back upstream	2872-2895	0604-0623
Elm Springs Southwest		2895-2917	0623-0640
Boneita Springs on top of Elm Springs			
Elm Springs South		2917-2945	0640-0657
Dalzell Northwest		2945-2970	0657-0676
Dalzell South on bottom of Dalzell Northwest			
Dalzell Northeast		2971-2993	0677-0694
Pedro Northwest		2994-3010	0694-0704
Pedro		3010-3031	0704-0722
Howe		3010-3036	0704-0726
Bridger		3036-3048	0726-0743
Bridger Southeast		3048-3065	0743-0759
Rattlesnake Lake Southwest		3065-3075	0759-0770

APPENDIX 2 (Continued)

BELLE FOURCHE RIVER IMAGERY FRAME DATA

USGS Quad	High Altitude	Low Altitude Roll #1	Low Altitude Roll #2
Rattlesnake Lake Southeast		3075-3089	0770-0783
Cherry Creek		3089-3100	0783-0794
Cherry Creek Northwest		---	0794-0802
Carlin Flat		---	0802-0819

APPENDIX 3

SURFACE AREA OF TAILING CONCENTRATIONS
Whitewood Creek

Shaded Area No.	Area ($Ft.^2$)		Shaded Area No.	Area ($Ft.^2$)	
1	119,808	(Deadwood, S.D.)	22	138,240	(St. Onge Southeast)
2	331,776	(Sturgis, S.D.)	23	211,968	
3	46,080		24	221,184	
4	202,752		25	230,400	
5	27,648		26	239,616	
6	27,648		27	73,728	
7	36,864		28	27,648	
8	73,728		29	27,648	
9	27,648		30	55,296	
10	396,288		31	119,808	
11	663,552		32	294,912	
12	55,296		33	304,128	
13	783,360	(St. Onge Southeast)	34	516,096	
14	340,992		35	175,104	
15	82,944		36	221,184	
16	119,808		37	433,152	
17	92,160		38	55,296	(Vale, S.D.)
18	525,312		39	405,504	
19	267,264		40	55,296	
20	92,160		41	92,160	
21	276,480		42	36,864	
			43	285,696	

APPENDIX 4

SURFACE AREA OF TAILING CONCENTRATIONS
Belle Fourche River

Shaded Area No.	Area ($Ft.^2$)		Shaded Area No.	Area ($Ft.^2$)	
1	43,500	(Newell, S.D.)	21	117,150	(Vale Northeast S.D.)
2	20,900		22	122,500	
3	104,500		23	180,500	
4	682,500		24	241,400	
5	38,500		25	34,200	
6	740,000		26	114,000	
7	142,100		27	210,000	
8	75,200		28	114,000	
9	33,250		29	326,800	
10	840,000		30	240,000	
11	180,500		31	43,300	
11A	191,400		32	168,000	
12	180,500		33	420,000	
13	332,500		34	1,476,000	
14	420,000	(Vale Northeast, S.D.)	35	240,000	
15	235,200		36	240,000	
16	16,800		37	221,000	
17	235,200		38	210,000	
18	960,000		39	247,000	
19	43,200		40	114,000	
20	168,000		41	79,800	

APPENDIX 4 (Continued)

SURFACE AREA OF TAILING CONCENTRATIONS
Belle Fourche River

Shaded Area No.	Area ($Ft.^2$)		Shaded Area No.	Area ($Ft.^2$)	
42	168,000	(Vale Northeast, S.D.)	63	35,000	(Volunteer, S.D.)
43	35,000		64	240,000	
44	1,080,000		65	258,750	
45	44,000		66	204,000	
46	80,000		67	216,000	
47	32,000		68	210,000	
48	36,000		69	199,500	
49	91,000		70	276,400	
50	228,000		71	580,608	
51	34,800		72	180,800	
52	657,600	(Vale Southeast, S.D.)	73	940,032	
53	408,000		74	101,376	
54	180,500		75	294,912	
55	210,000	(Volunteer, S.D.)	76	276,480	
56	28,000		77	119,808	
57	840,000		78	156,672	
58	472,500		79	92,160	
59	115,000		80	387,072	
60	41,000		81	230,400	
61	80,000		82	27,648	
62	152,000		83	438,048	

APPENDIX 4 (Continued)

SURFACE AREA OF TAILING CONCENTRATIONS
Belle Fourche River

Shaded Area No.	Area ($Ft.^2$)		Shaded Area No.	Area ($Ft.^2$)	
84	599,040	(Volunteer, S.D.)	105	175,000	(Volunteer, S.D.)
85	239,616		106	423,936	
86	138,240		107	73,728	
87	64,512		108	73,728	
88	64,512		109	635,904	
89	73,728		110	92,160	
90	82,944		111	239,616	
91	239,616		112	73,728	
92	46,080		113	110,592	
93	534,528		114	27,648	(Volunteer Southeast)
94	1,253,376		115	202,752	
95	313,344		116	46,080	
96	82,944		117	193,536	
97	230,400		118	285,696	
98	580,608		119	18,432	(Rapid City, S.D.)
99	479,232		120	285,695	
100	92,160		121	165,888	
101	414,720		122	73,728	
102	359,424		123	267,264	
103	73,728		124	396,288	
104	552,960		125	101,376	

APPENDIX 4 (Continued)

SURFACE AREA OF TAILING CONCENTRATIONS
Belle Fourche River

Shaded Area No.	Area ($Ft.^2$)		Shaded Area No.	Area ($Ft.^2$)	
126	46,080	(Rapid City, S.D.)	147	534,528	(Rapid City, S.D.)
127	313,344		148	138,240	
128	36,864		149	175,104	
129	202,752		150	221,184	
130	285,696		151	230,400	
131	304,128		152	55,296	
132	267,264		153	119,808	
133	73,728		154	193,536	
134	46,080		155	460,080	
135	442,368		156	92,160	
136	276,480		157	276,480	
137	442,368		158	211,968	
138	414,720		159	313,344	
139	350,208		160	304,128	
140	285,696		161	248,832	
141	211,968		162	211,968	
142	672,768		163	165,888	
143	405,504		164	267,264	(Hereford, S.D.)
144	36,864		165	470,016	
145	580,608		166	46,080	
146	442,368		167	764,928	

APPENDIX 4 (Continued)

SURFACE AREA OF TAILING CONCENTRATIONS
Belle Fourche River

Shaded Area No.	Area ($Ft.^2$)		Shaded Area No.	Area ($Ft.^2$)	
168	129,024	(Hereford, S.D.)	189	571,392	(Hereford South-west)
169	691,200		190	101,376	
170	46,080		191	635,904	
171	239,616		192	55,296	
172	479,232		193	184,320	
173	27,648		194	92,160	
174	359,424		195	239,616	
175	276,480	(Hereford South-west)	196	46,080	
176	331,776		197	267,264	(Hereford South-east)
177	304,128		198	599,040	
178	313,344		199	294,912	
179	36,864		200	543,744	
180	276,480		201	55,296	
181	202,752		202	423,936	
182	27,648		203	304,128	
183	912,384		204	36,864	
184	322,560		205	129,024	
185	55,296		206	792,576	
186	368,640		207	248,832	
187	387,072		208	294,192	
188	829,440		209	101,376	

APPENDIX 4 (Continued)

SURFACE AREA OF TAILING CONCENTRATIONS
Belle Fourche River

Shaded Area No.	Area (Ft.^{2})		Shaded Area No.	Area (Ft.^{2})	
210	294,912	(Hereford Southeast)	230	221,184	(Elm Springs Southwest)
211	562,176		231	156,672	
212	534,528		232	340,992	
213	497,664		233	267,264	
214	396,288		234	552,960	
215	258,048		235	101,376	
216	626,688		236	165,888	
217	654,336		237	387,072	
218	451,584		238	110,592	
219	1,262,592		239	460,800	
220	211,968		240	599,040	
221	1,345,536	(Elm Springs Southwest)	241	202,752	
222	672,768		242	138,240	(Elm Springs)
223	331,776		243	479,232	
224	608,256		244	73,728	
225	479,232		245	350,208	
226	304,128		246	396,288	
227	73,728		247	55,296	
228	340,992		248	193,536	
229	55,296		249	396,288	

APPENDIX 4 (Continued)

SURFACE AREA OF TAILING CONCENTRATIONS
Belle Fourche River

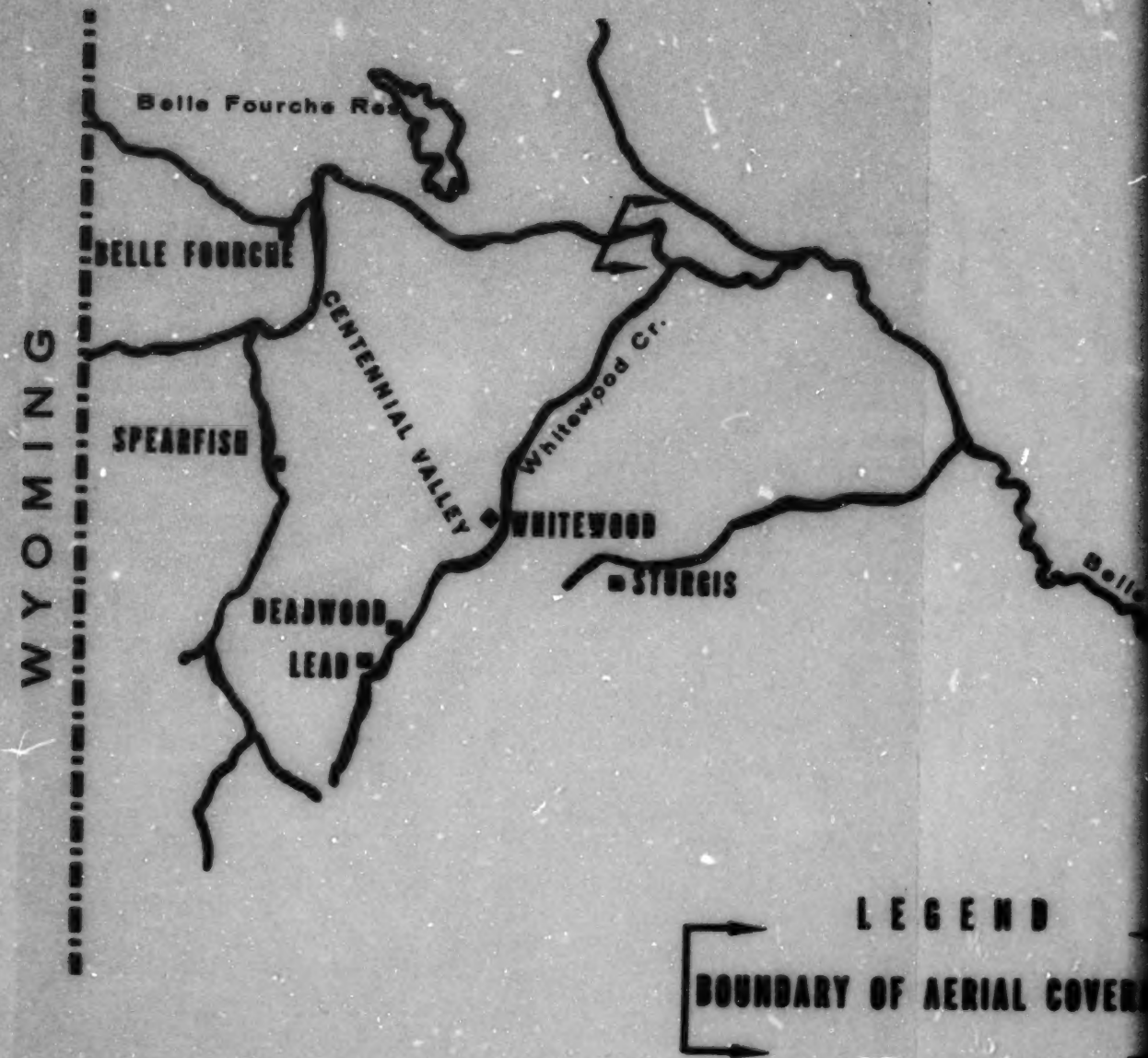
Shaded Area No.	Area (Ft.^{2})		Shaded Area No.	Area (Ft.^{2})	
250	967,680	(Elm Springs)	271	1,013,760	(Dalzell North-west)
251	580,608		272	82,944	
252	866,304		273	516,096	
253	405,504		274	359,424	
254	479,232		275	672,768	
255	442,368		276	340,992	
256	285,696		277	129,024	
257	534,528		278	221,184	
258	110,592		279	847,872	
259	276,480		280	442,360	
260	55,296	(Dalzell North-west)	281	193,536	
261	211,968		282	64,512	
262	211,968		283	368,640	
263	626,688		284	294,912	
264	129,024		285	276,480	
265	156,672		286	165,888	
266	230,400		287	442,368	(Dalzell North-east, S.D.)
267	193,536		288	1,059,840	
268	359,424		289	488,448	
269	654,336		290	866,304	
270	599,040		291	1,216,512	

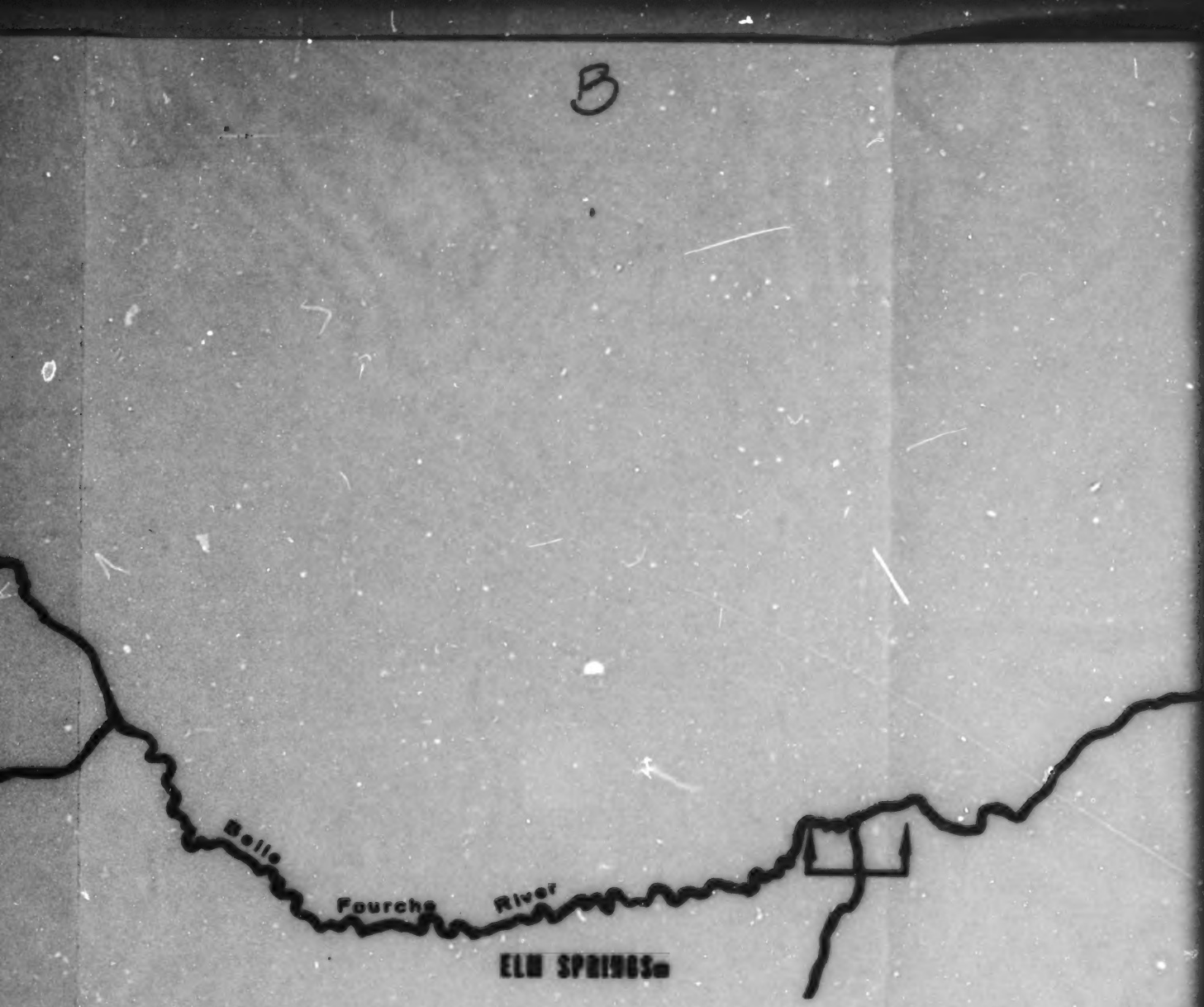
APPENDIX 4 (Continued)

SURFACE AREA OF TAILING CONCENTRATIONS
Bello Fourche River

Shaded Area No.	Area (Ft.^{2})		Shaded Area No.	Area (Ft.^{2})
292	82,944	(Dalzell North-east, S.D.)		
293	654,336			
294	101,376			
295	728,064			
296	396,288			
297	350,208			
298	230,400			
299	571,392			
300	866,304			
301	1,198,080			
302	184,320			
303	635,904			
304	894,736			
305	129,024			
306	193,536			
307	645,120			
308	101,376			
309	294,912			

A

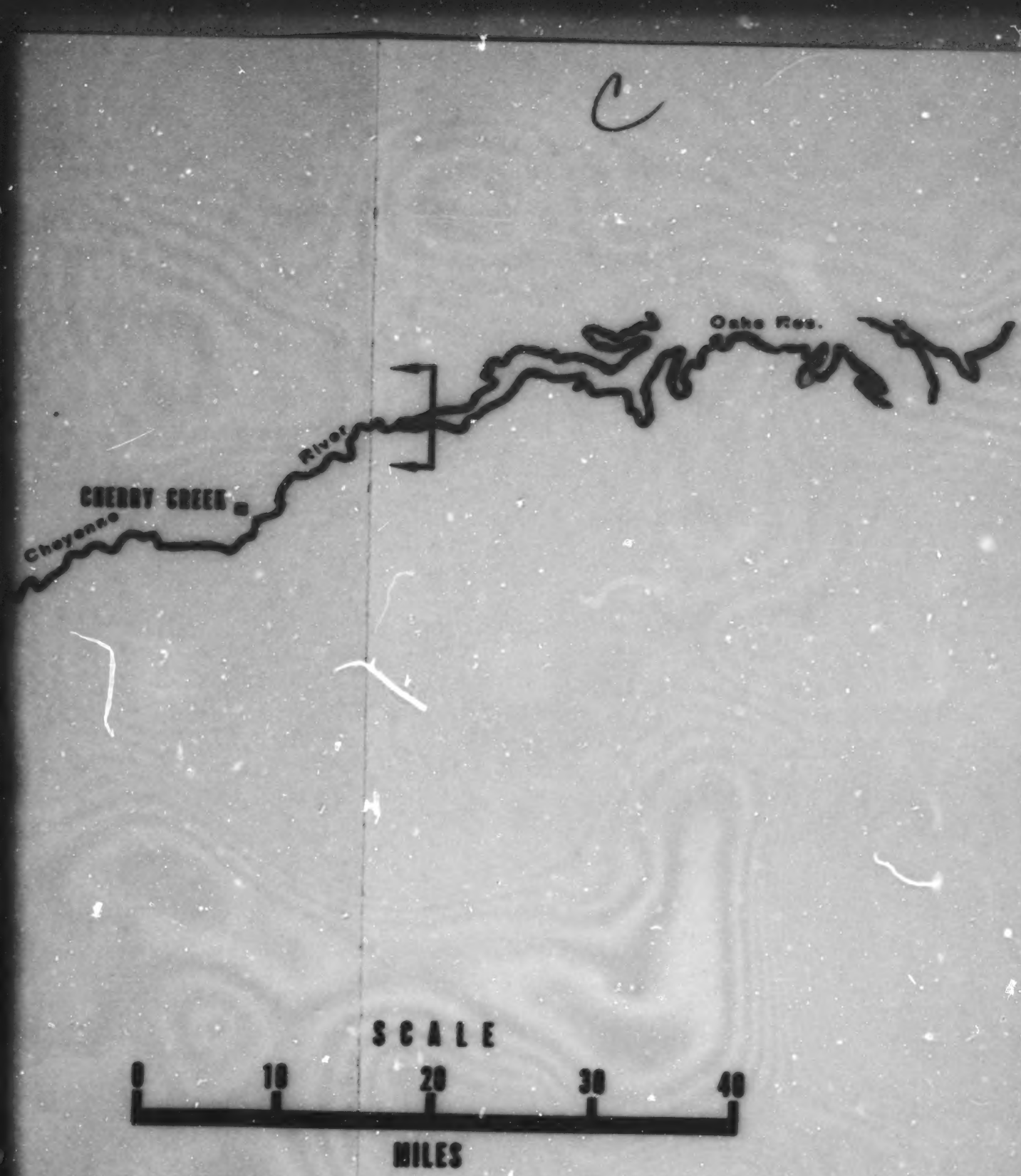

Belle Fourche Res
BELLE FOURCHE
WYOMING
CENTENNIAL VALLEY
Whitewood Cr.
SPEARFISH
WHITEWOOD
STURGIS
DEADWOOD
LEAD
LEGEND
BOUNDARY OF AERIAL COVER



LEGEND

Y OF AERIAL COVERAGE

Figure 1. L



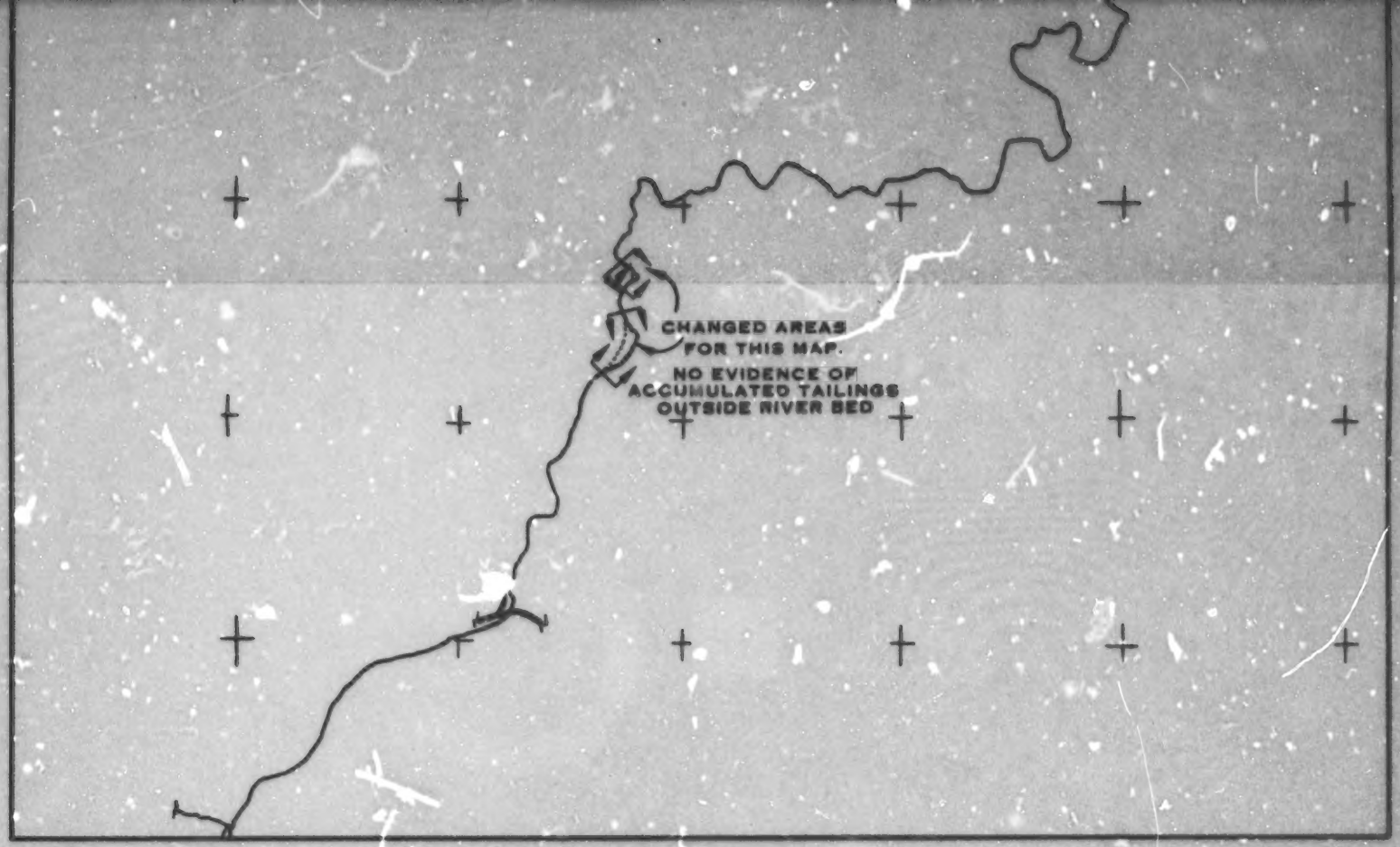
on Map Showing Aerial Coverage, Western South Dakota

A

TAILINGS DEPOSIT

CHANGED AREAS FOR THIS MAP.

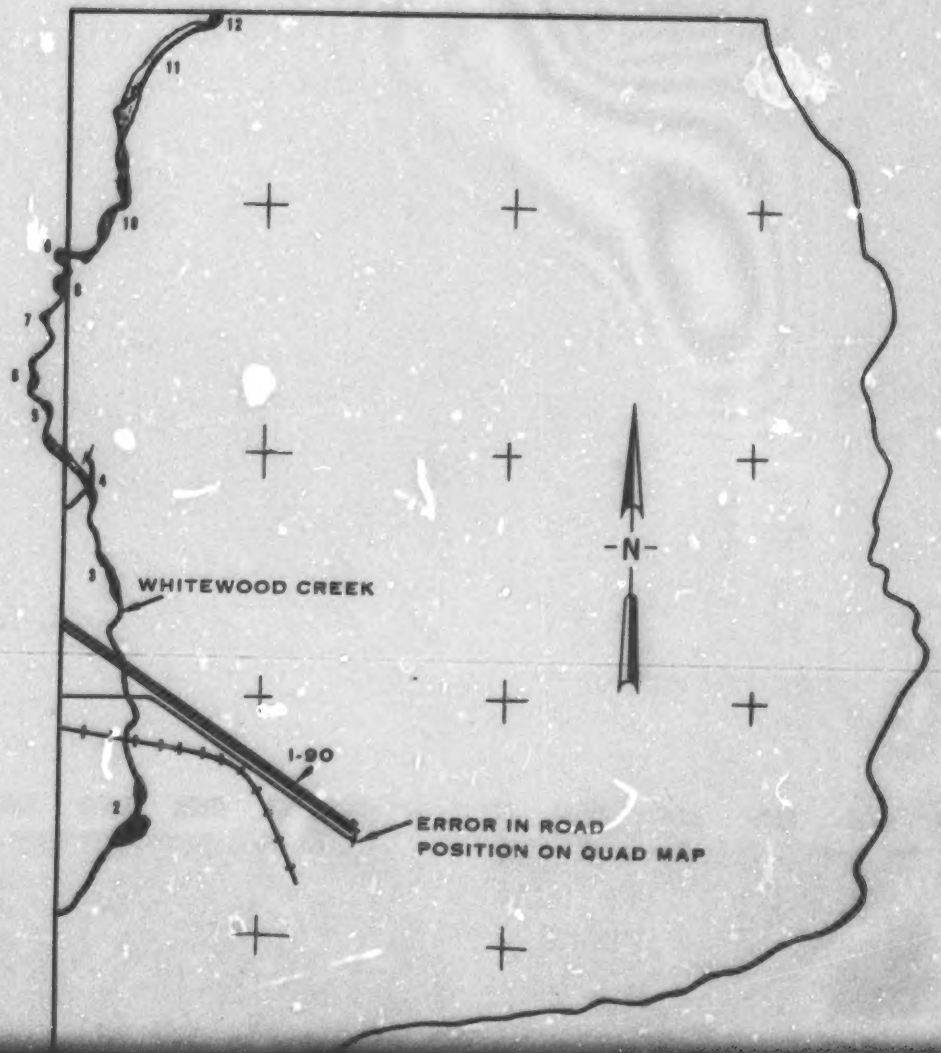
NO EVIDENCE OF ACCUMULATED TAILINGS OUTSIDE RIVER BED



NOTE
SHADED AREAS ARE
TAILING DEPOSITS

FIGURE 2 OVERLAY FOR DEADWOOD NORTH, SOUTH DAKOTA 7.5' QUAD MAP
20/23 NOVEMBER 1971

FRAMES 3311-3302-H.A.


12
11
10
9
8
7
6
5
4
3
2
WHITEWOOD CREEK
I-90
ERROR IN ROAD
POSITION ON QUAD MAP
-N-

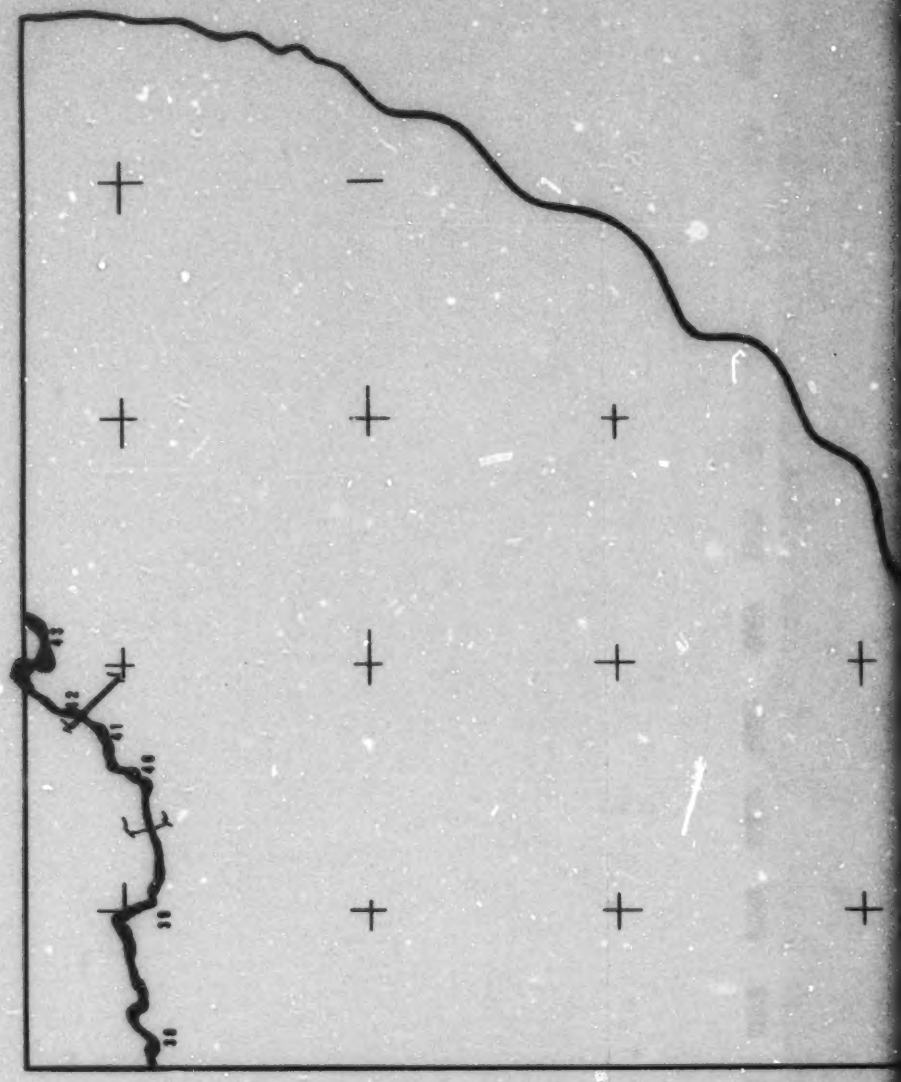
22x

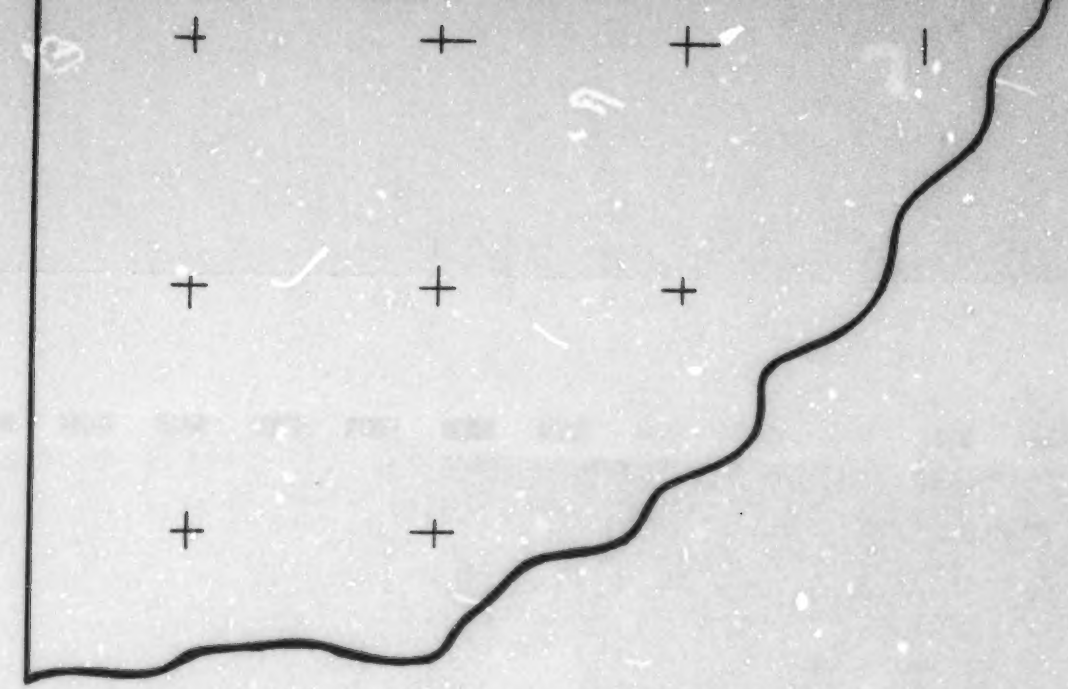
NOTE
SHADED AREAS ARE
TAILING DEPOSITS

FIGURE 3 OVERLAY FOR STURGIS,SOUTH DAKOTA 7.5' QUAD MAP
20/23 NOVEMBER 1971

FRAMES 3302-3295

A



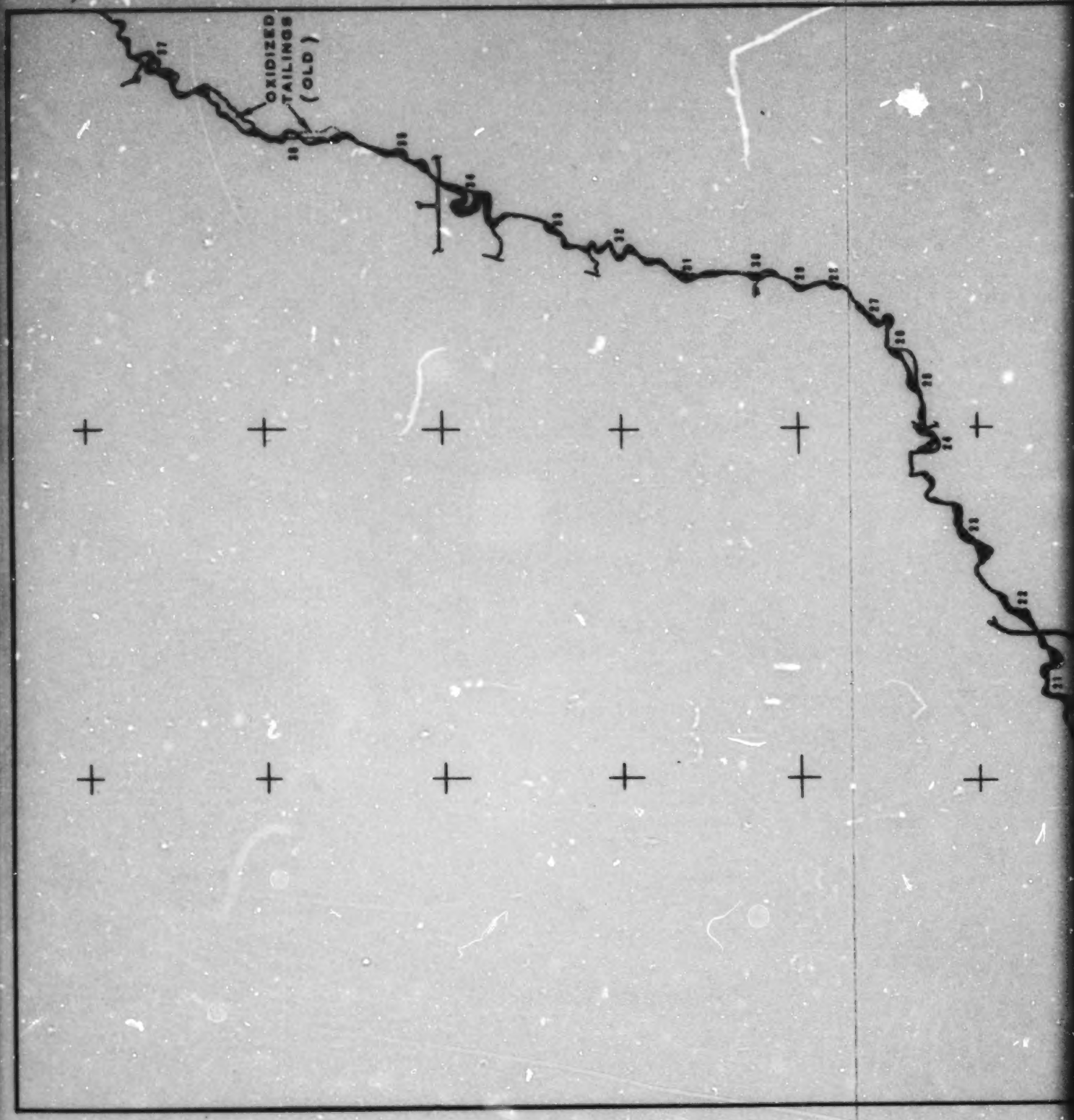


NOTE
SHADED AREAS ARE
TAILING DEPOSITS

FIGURE 4. OVERLAY FOR YALE,SOUTH DAKOTA 7.5' QUAD MAP
20/23 NOVEMBER 1971

FRAMES 3288 H.A.

A



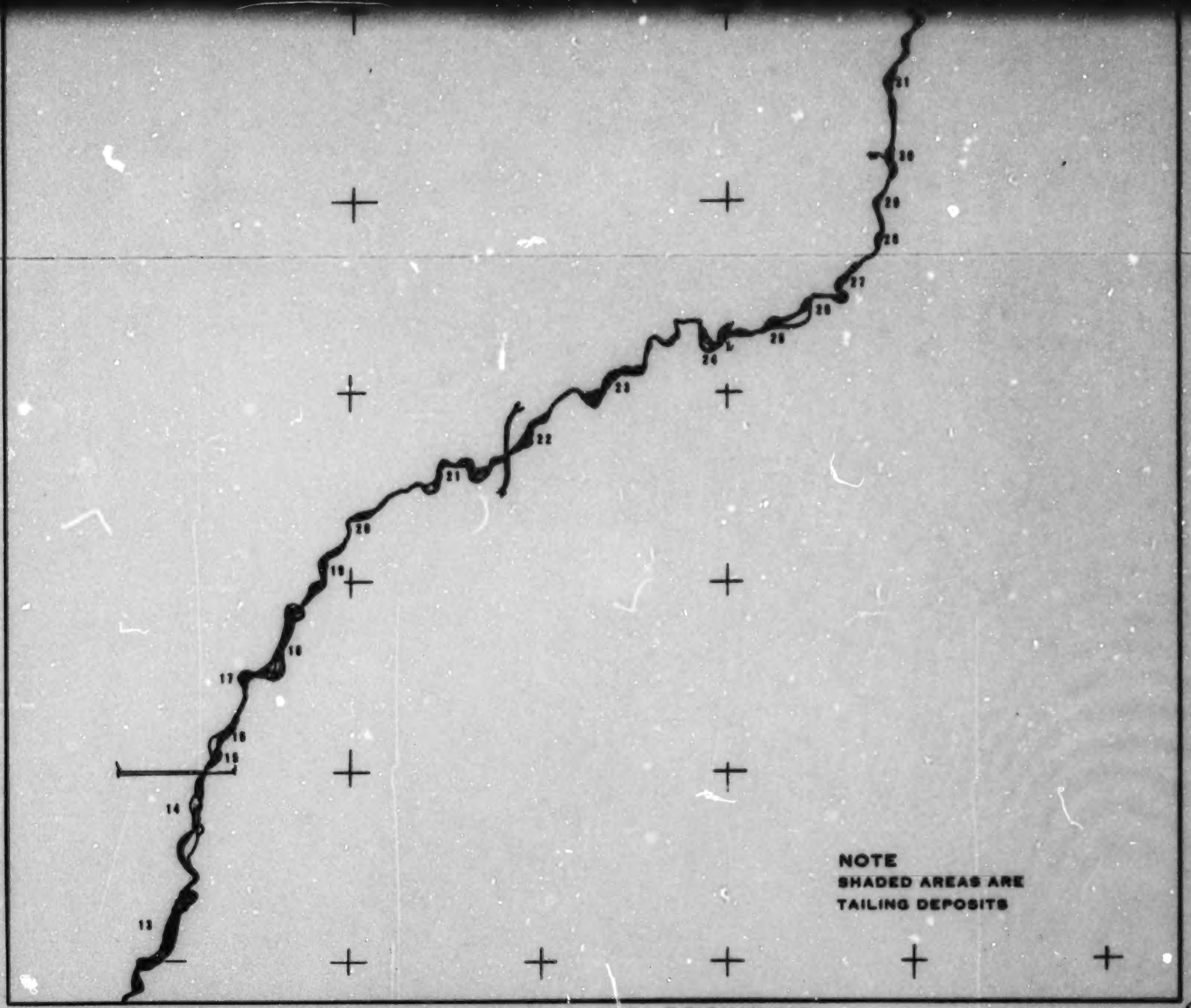
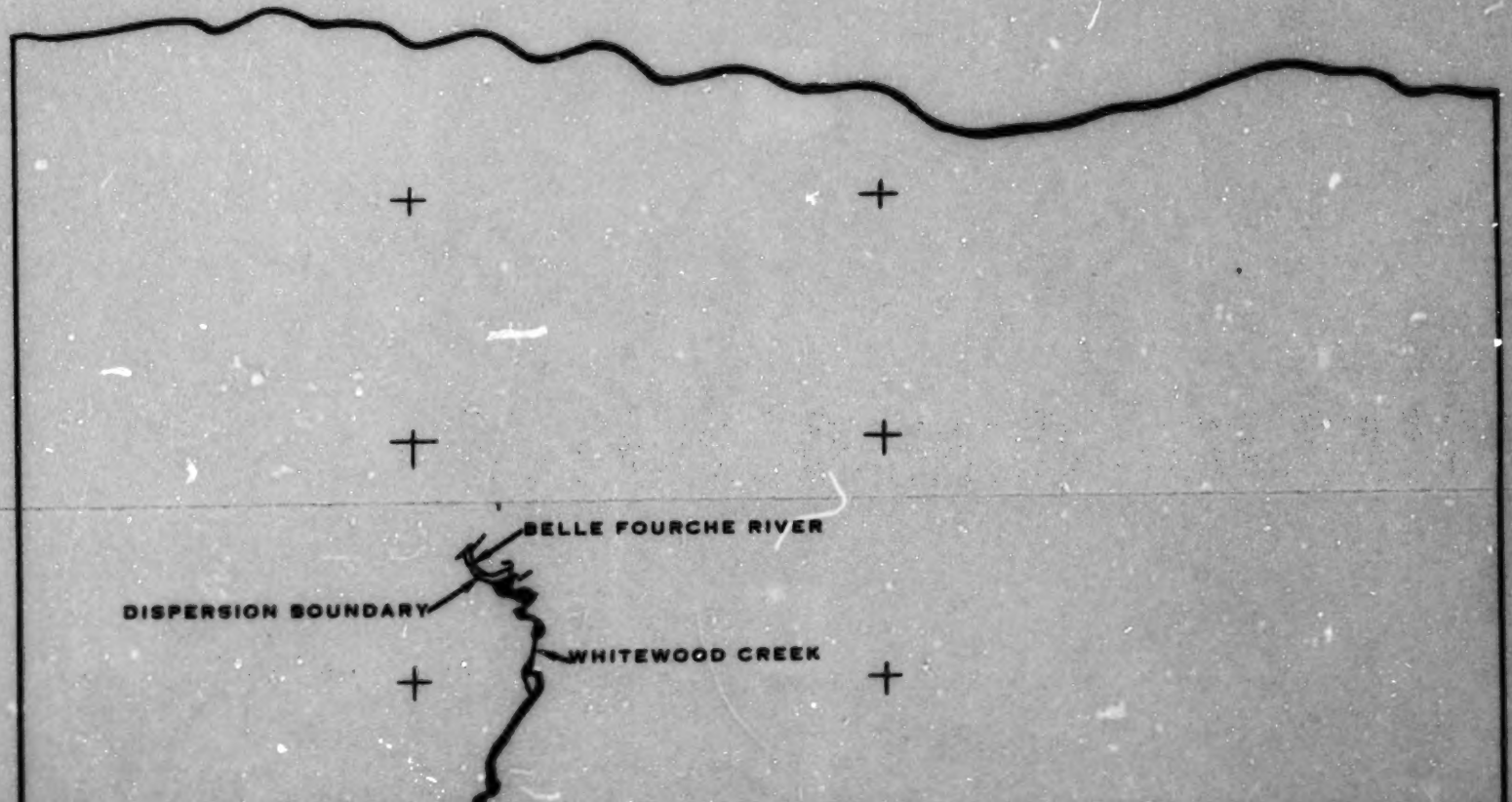
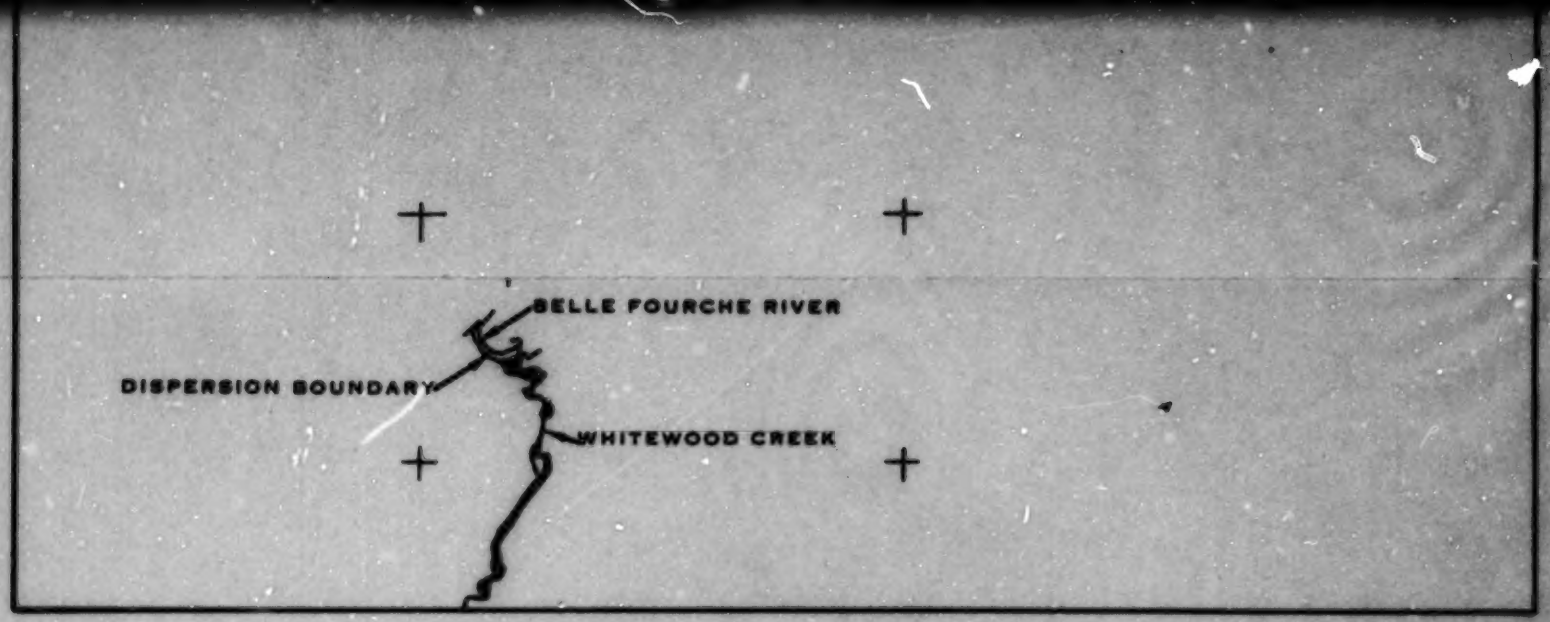


FIGURE 5. OVERLAY FOR SAINT ONGE S.E, SOUTH DAKOTA 7.5' QUAD. MAP
20/23 NOVEMBER 1971

FRAMES 3298-3288


BELLE FOURCHE RIVER
DISPERSION BOUNDARY
WHITEWOOD CREEK



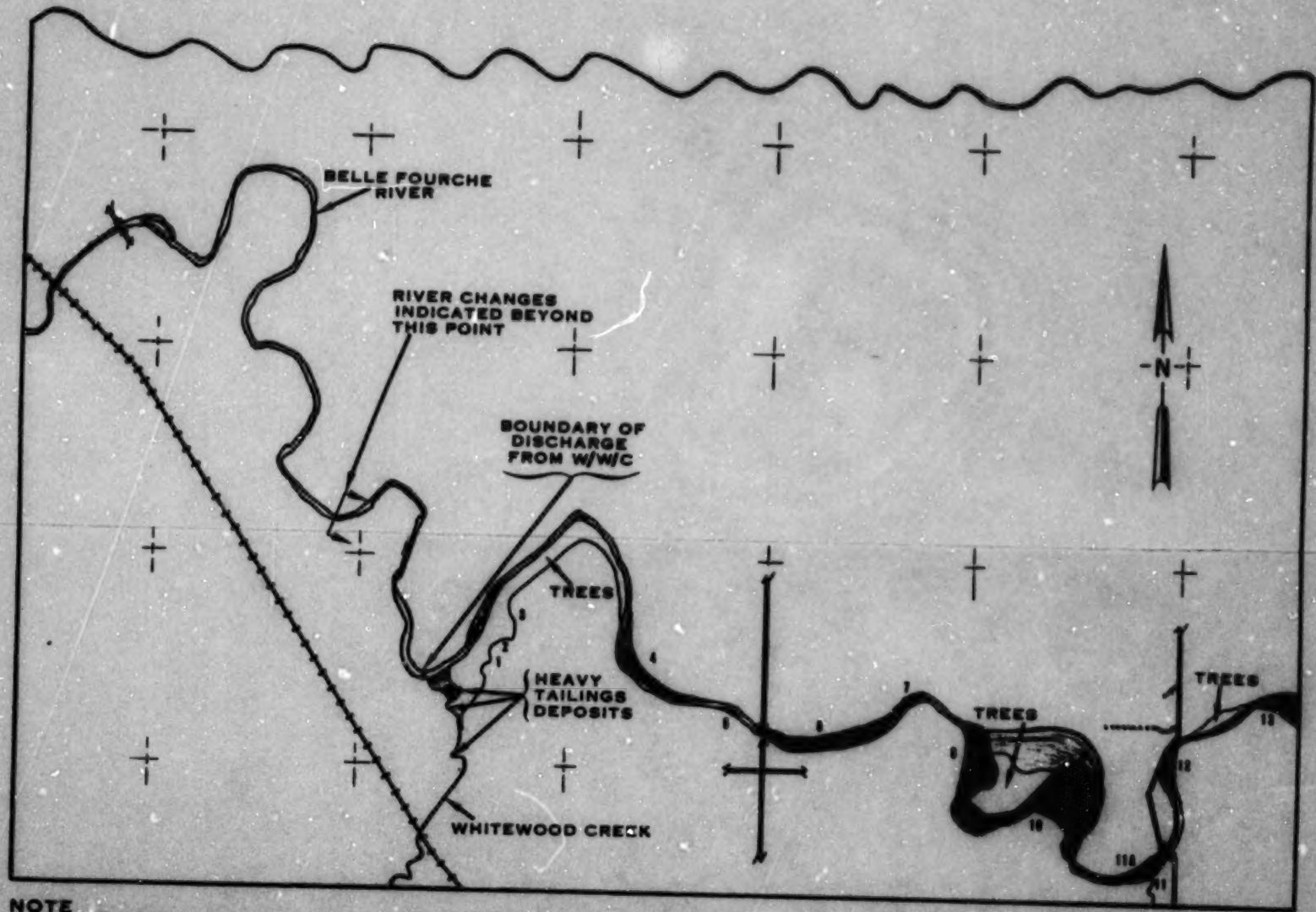
NOTE
SHADED AREAS ARE
TAILING DEPOSITS

25x

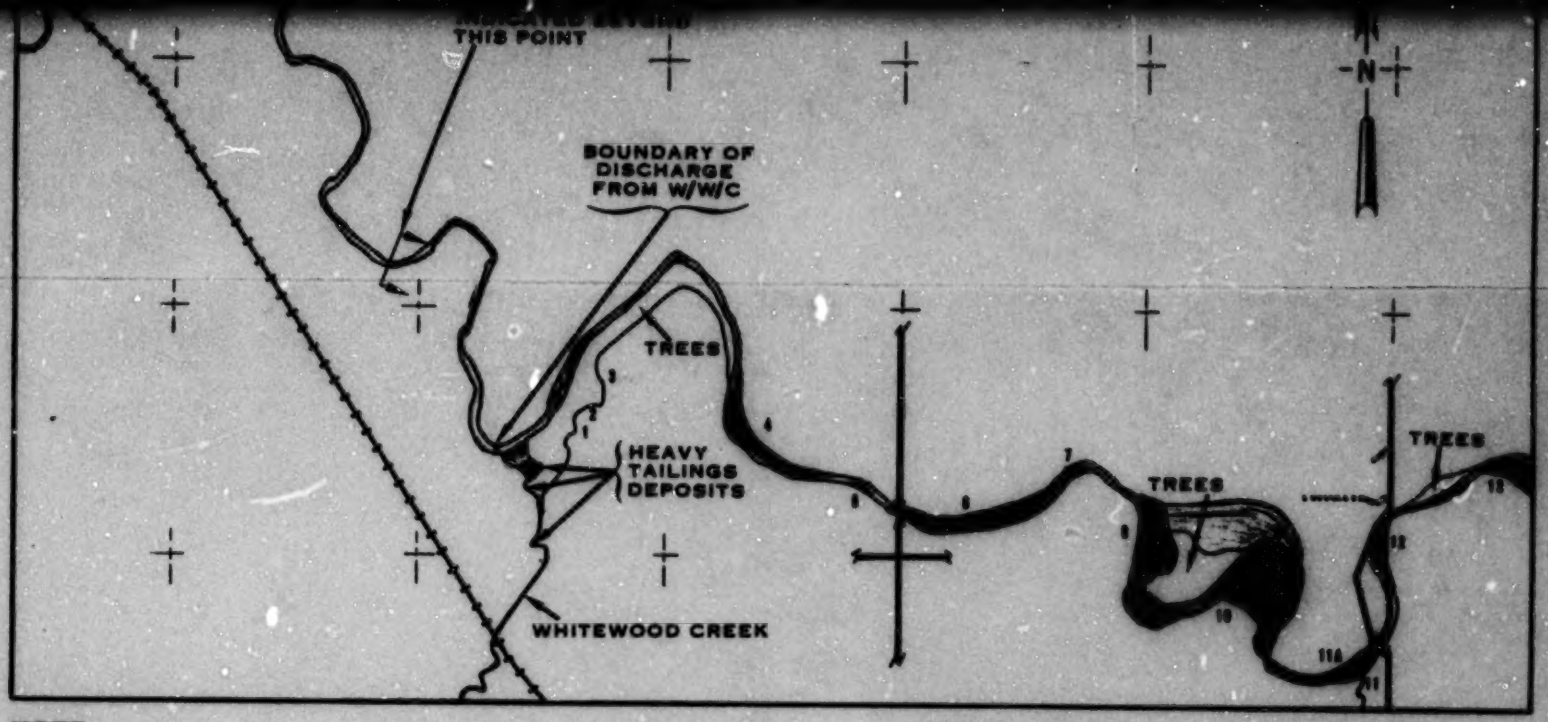
3

FIGURE 6 OVERLAY FOR NEWELL,SOUTH DAKOTA 7.5' QUAD MAP (WHITEWOOD CREEK ONLY)
20/23 NOVEMBER 1971

FRAME 3267 H.A.


BELLE FOURCHE RIVER
RIVER CHANGES INDICATED BEYOND THIS POINT
BOUNDARY OF DISCHARGE FROM W/W/C
N
TREES
HEAVY TAILINGS DEPOSITS
WHITEWOOD CREEK
TREES
TREES

NOTE



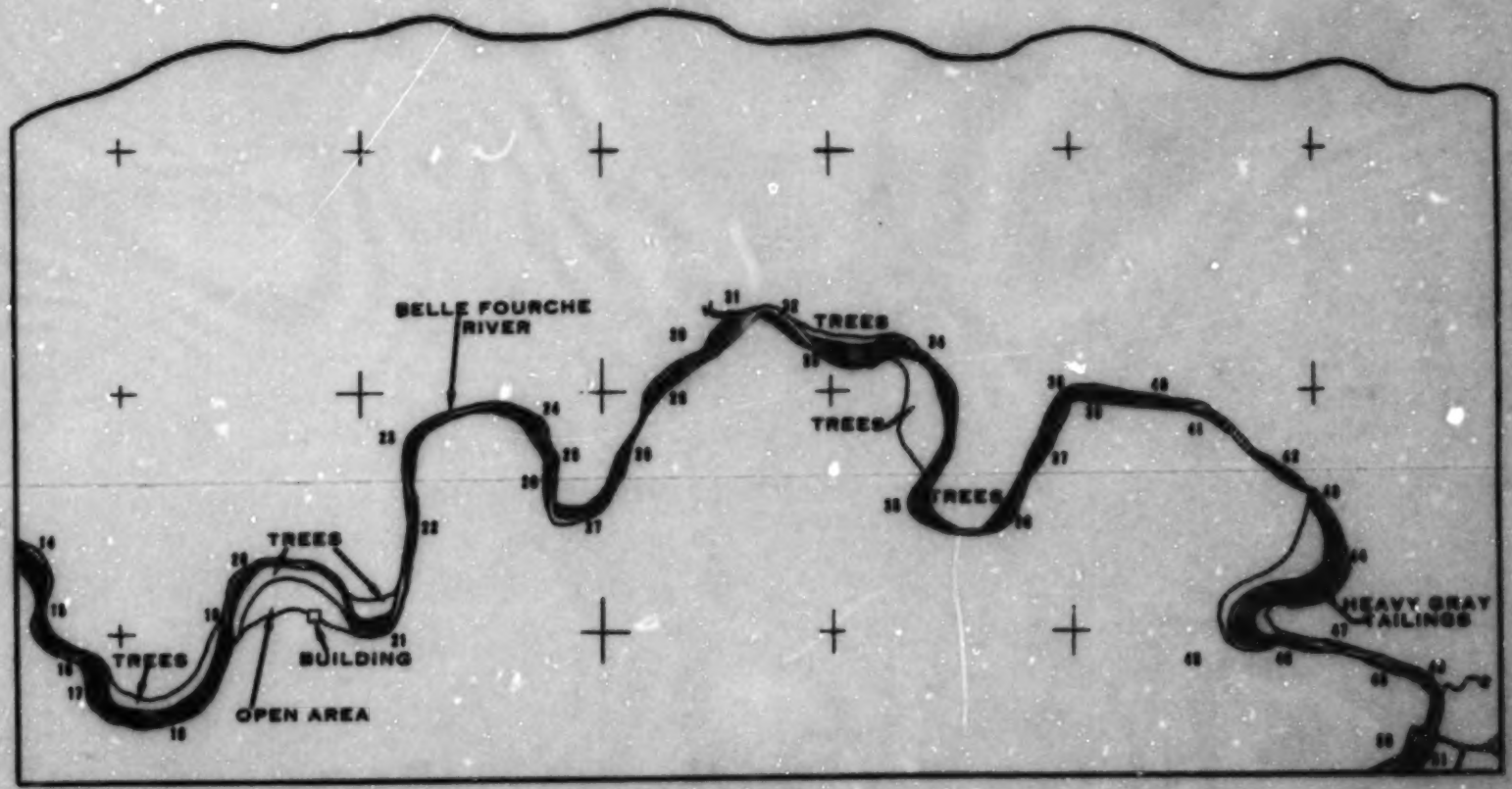
NOTE
SHADED AREAS ARE
TAILING DEPOSITS

26<

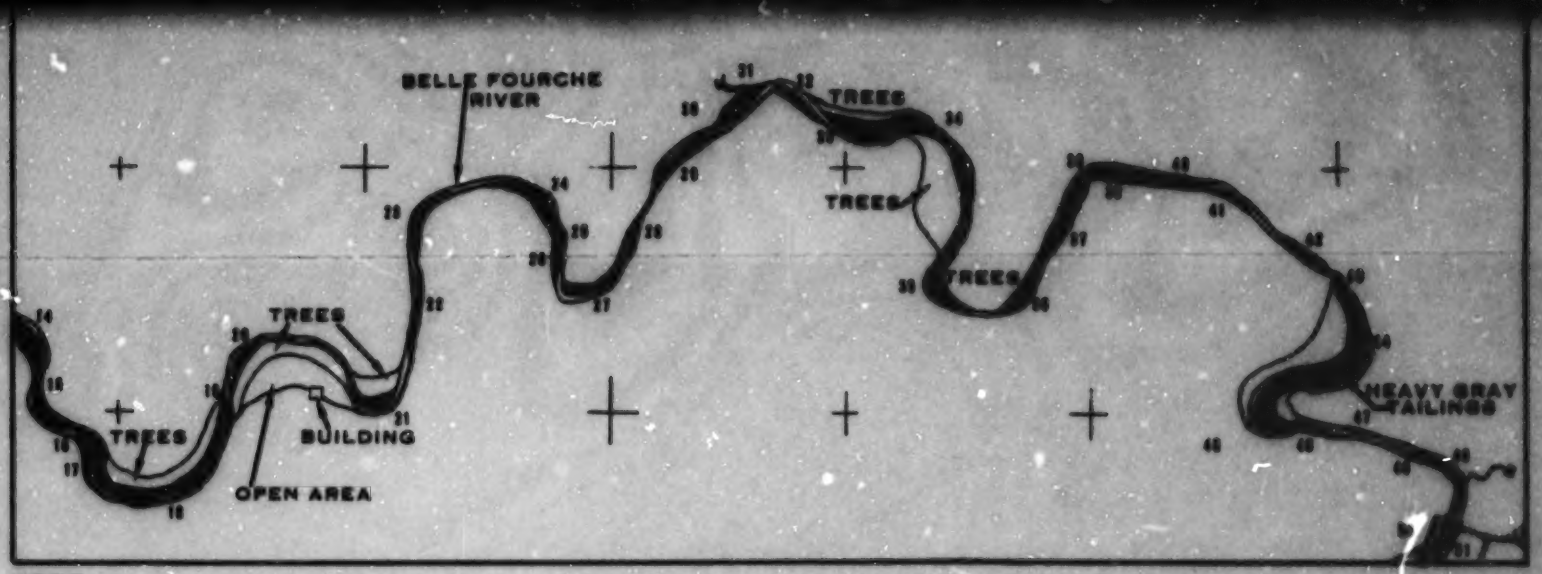
B

FIGURE 7 OVERLAY FOR NEWELL, SOUTH DAKOTA 7.5' QUAD MAP
FLIGHTS 20/23 NOVEMBER 1971

FRAMES 3287-3283-HA



NOTE
SHADED AREAS ARE
TAILING DEPOSITS



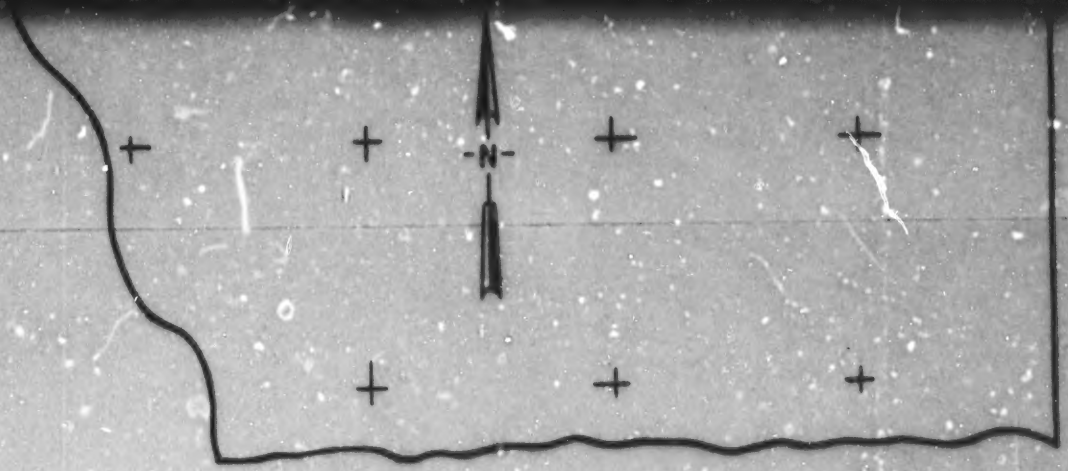
NOTE
SHADED AREAS ARE
TAILING DEPOSITS

FIGURE 8 OVERLAY FOR VALE NE, SOUTH DAKOTA 7.5' QUAD MAP
FLIGHTS 20/23 NOVEMBER 1971

FRAMES 3383-3370-HA

A

NOTE

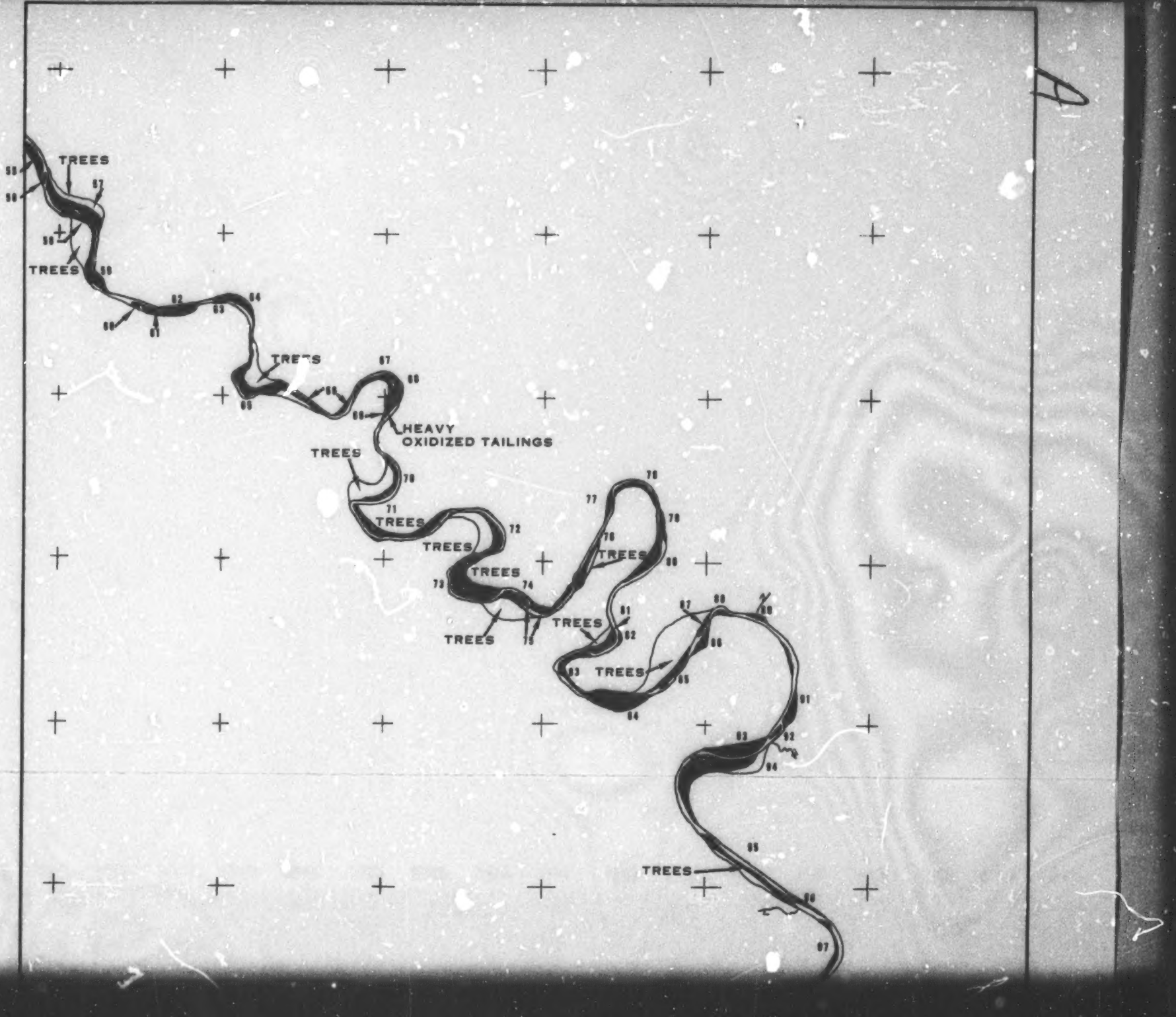


NOTE
SHADED AREAS ARE
TAILING DEPOSITS

28

FIGURE 9 OVERLAY FOR VALE SE, SOUTH DAKOTA 7.5' QUAD MAP
20/23 NOVEMBER 1971

FRAME 3270-NA


TREES
TREES
TREES
HEAVY
OXIDIZED TAILINGS
TREES
TREES
TREES
TREES
TREES
TREES
TREES
TREES
TREES

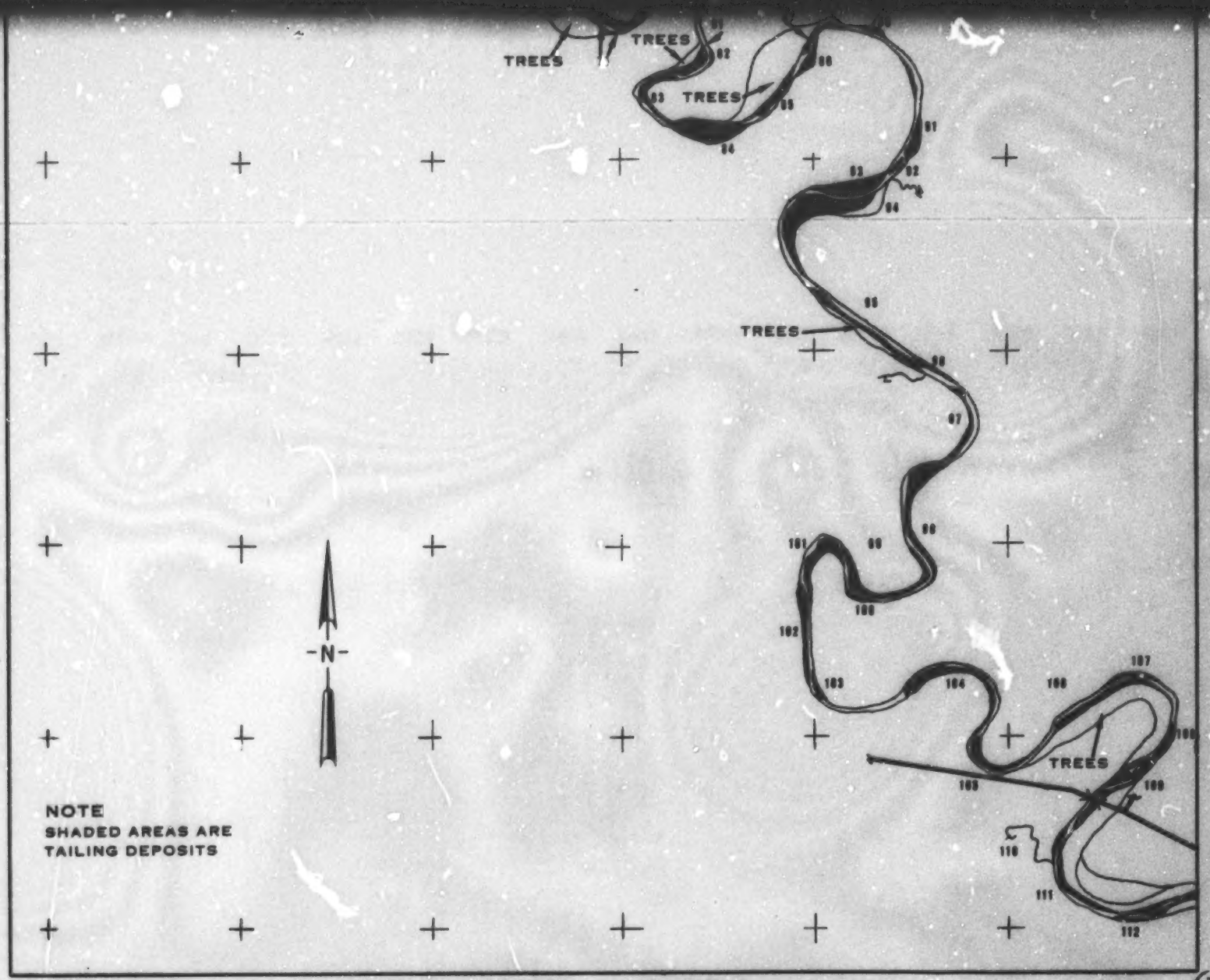
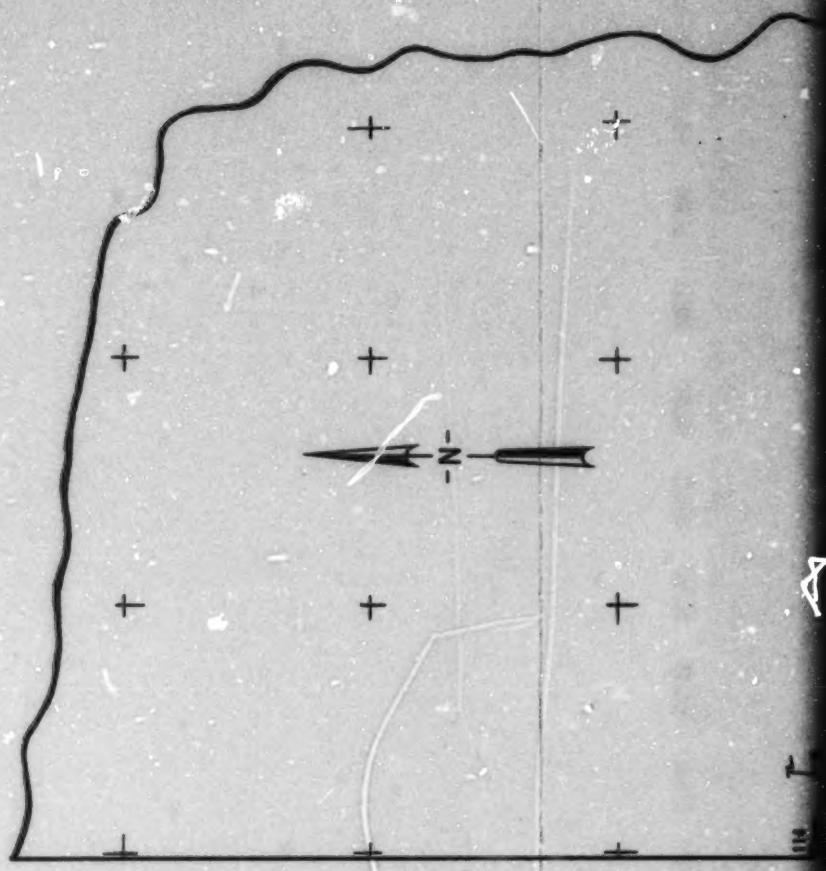


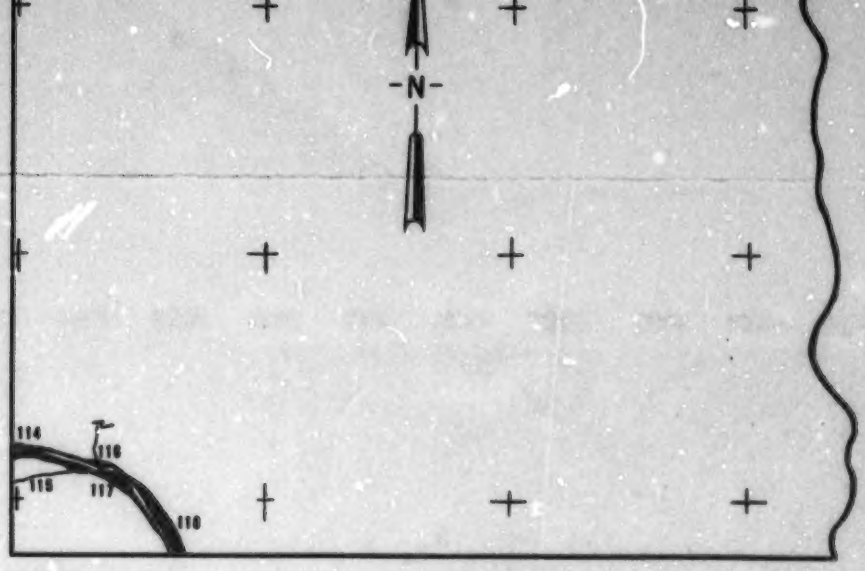
FIGURE 10 OVERLAY FOR VOLUNTEER,SOUTH DAKOTA 7.5' QUAD MAP
20/23 NOVEMBER 1971

FRAMES 3270-3259-HA

B

A

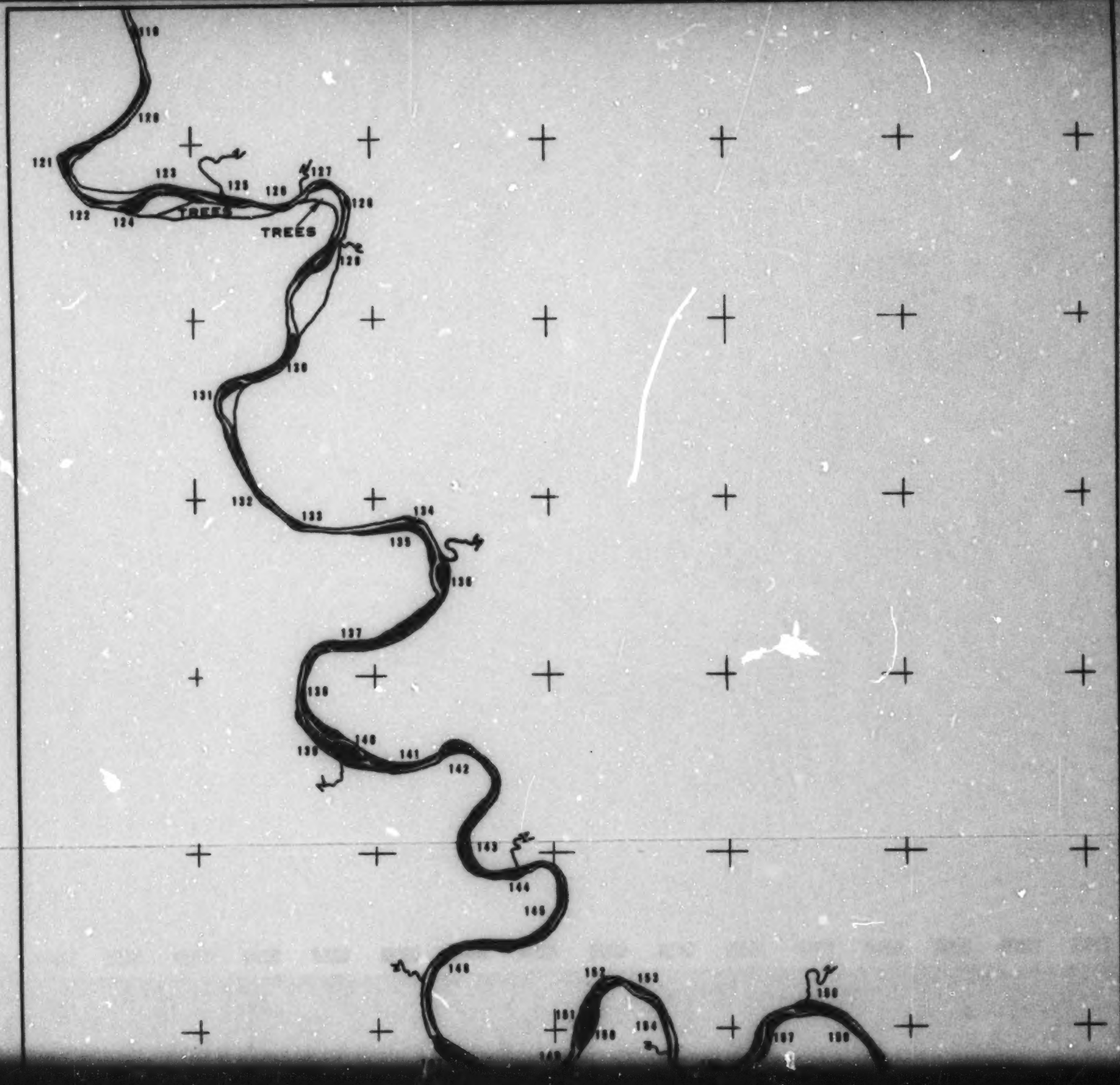




NOTE
SHADED AREAS ARE
TAILING DEPOSITS

FIGURE 11 OVERLAY FOR VOLUNTEER SE, SOUTH DAKOTA 7.5' QUAD MAP
20/23 NOVEMBER 1971

FRAME 3250


TREES
TREES

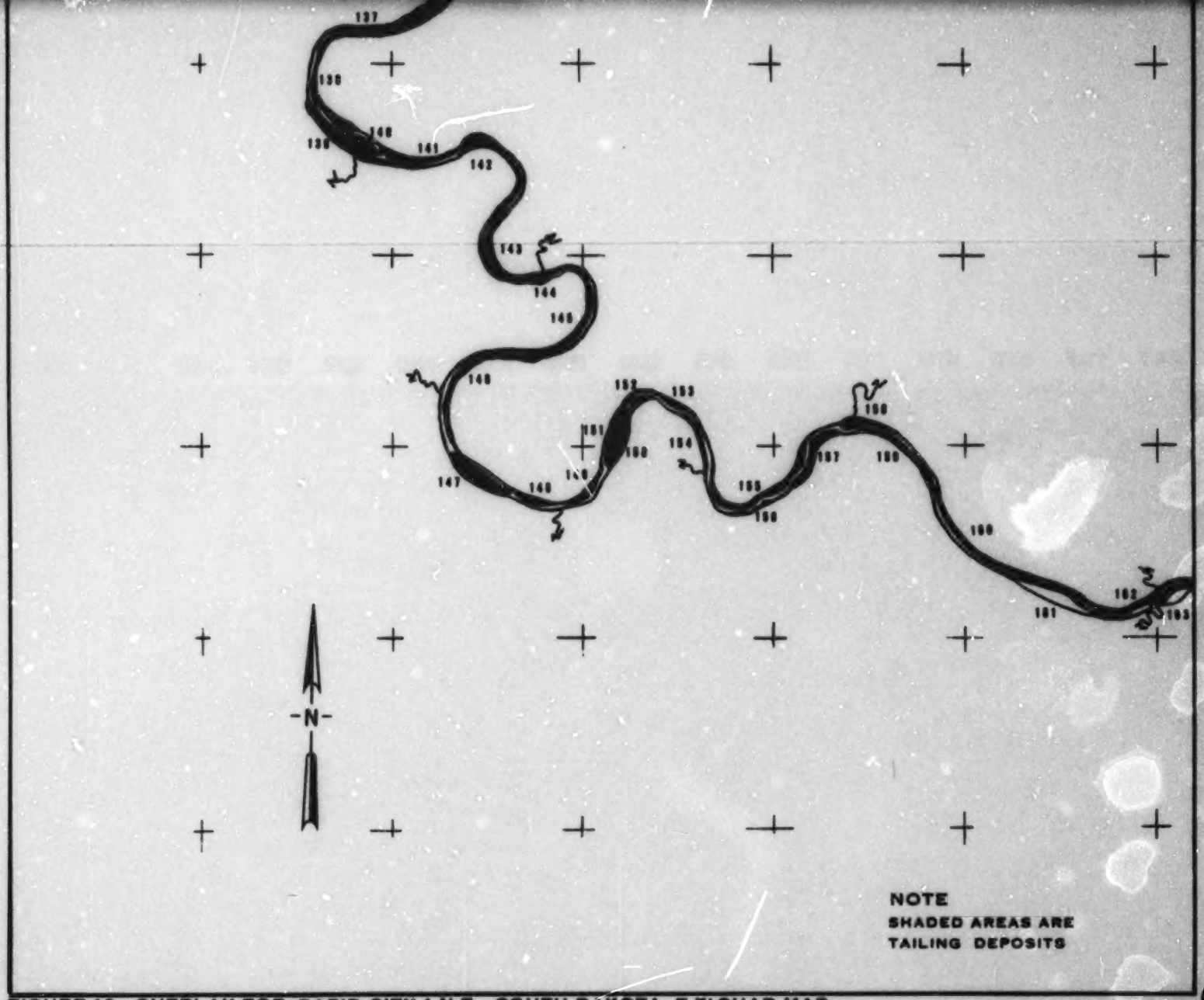
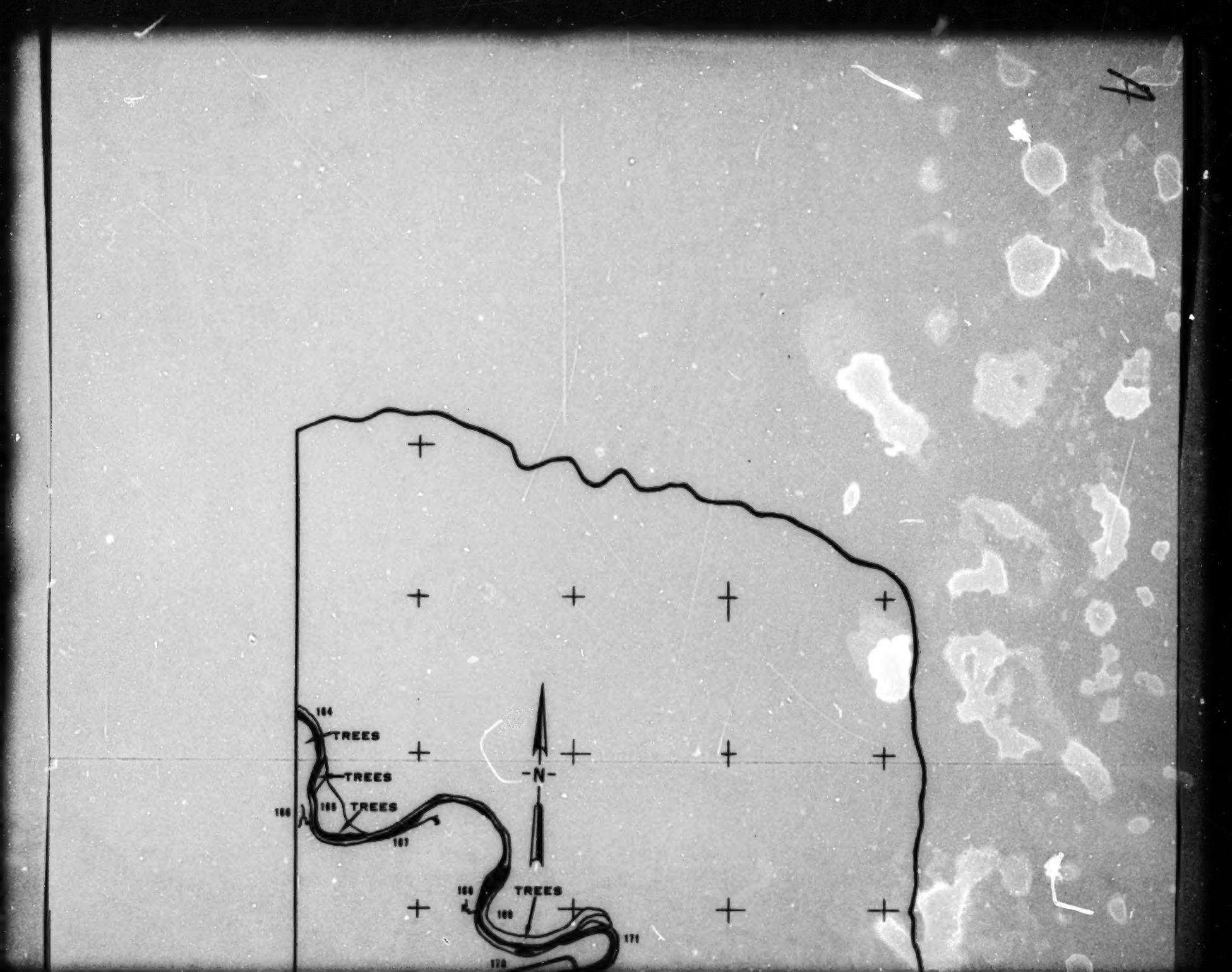
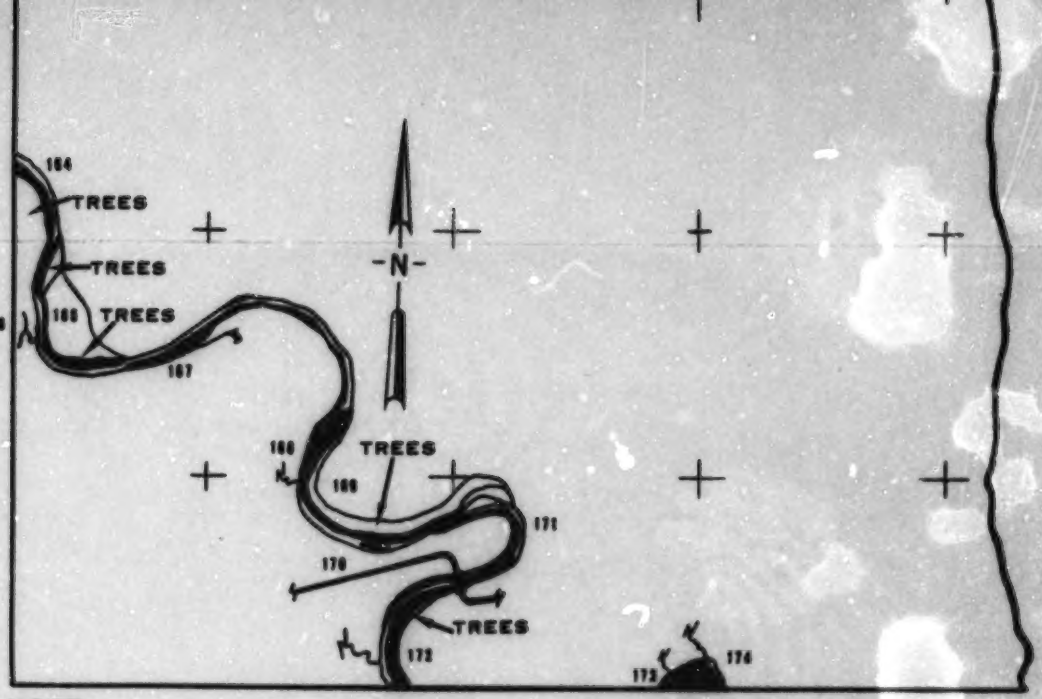


FIGURE 12 OVERLAY FOR RAPID CITY 1 N.E., SOUTH DAKOTA 7.5' QUAD MAP
FLIGHTS 20/23 NOVEMBER 1971

FRAMES 3259-3250 H.A.

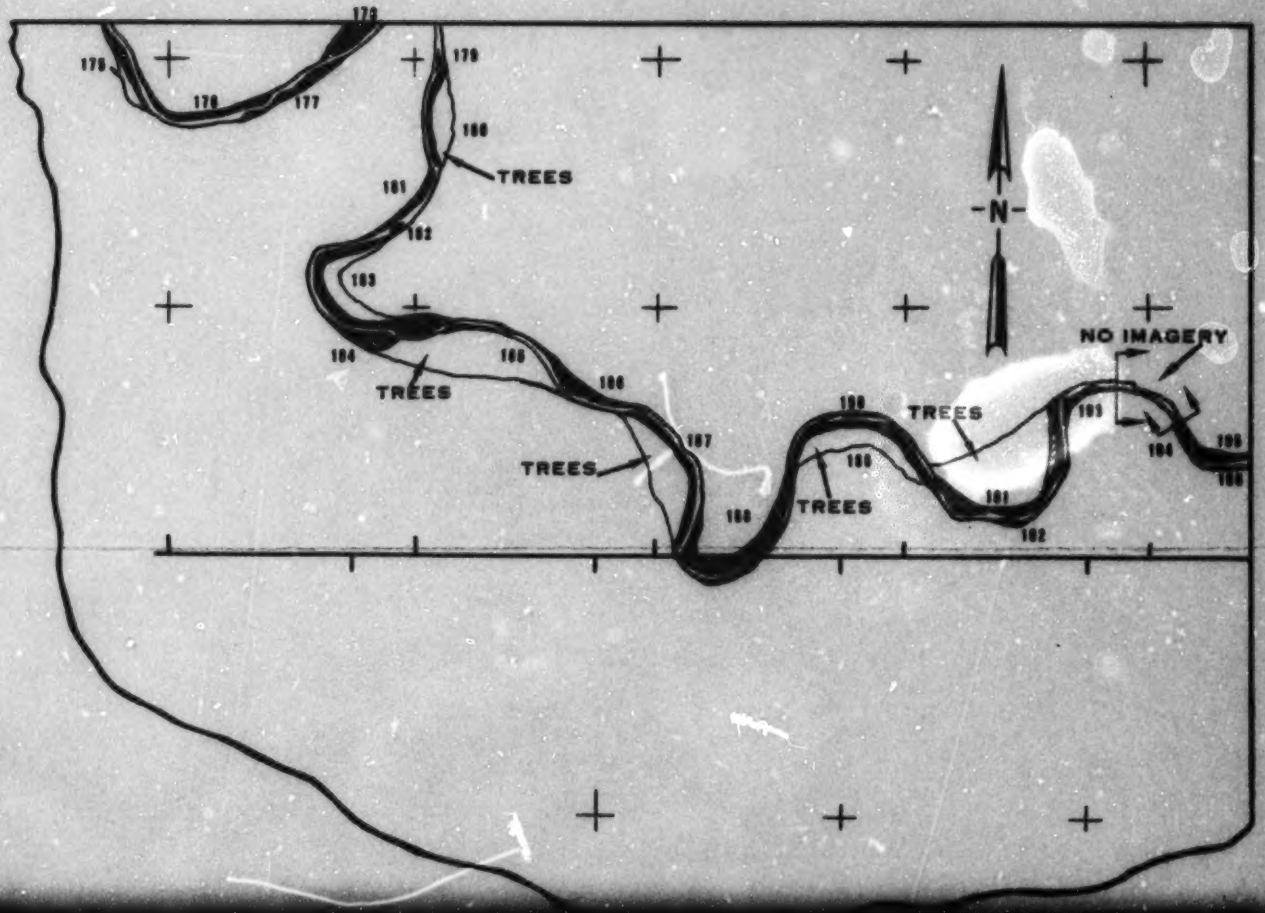

-N-
184
TREES
TREES
186
185
TREES
187
188
TREES
189
171
170

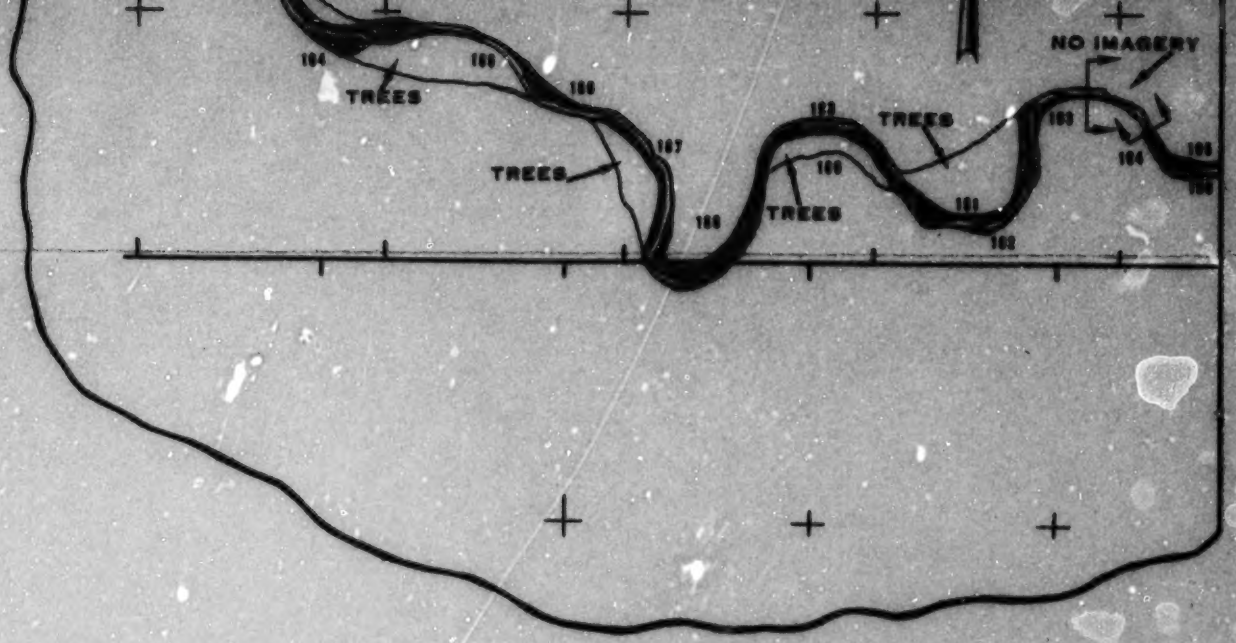


NOTE
SHADED AREAS ARE
TAILING DEPOSITS

FIGURE 13 OVERLAY FOR HEREFORD,SOUTH DAKOTA 7.5' QUAD MAP
FLIGHTS 20/23 NOVEMBER 1971

FRAMES 3250-3247-H.A.


175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
TREES
TREES
TREES
TREES
TREES
-N-
NO IMAGERY

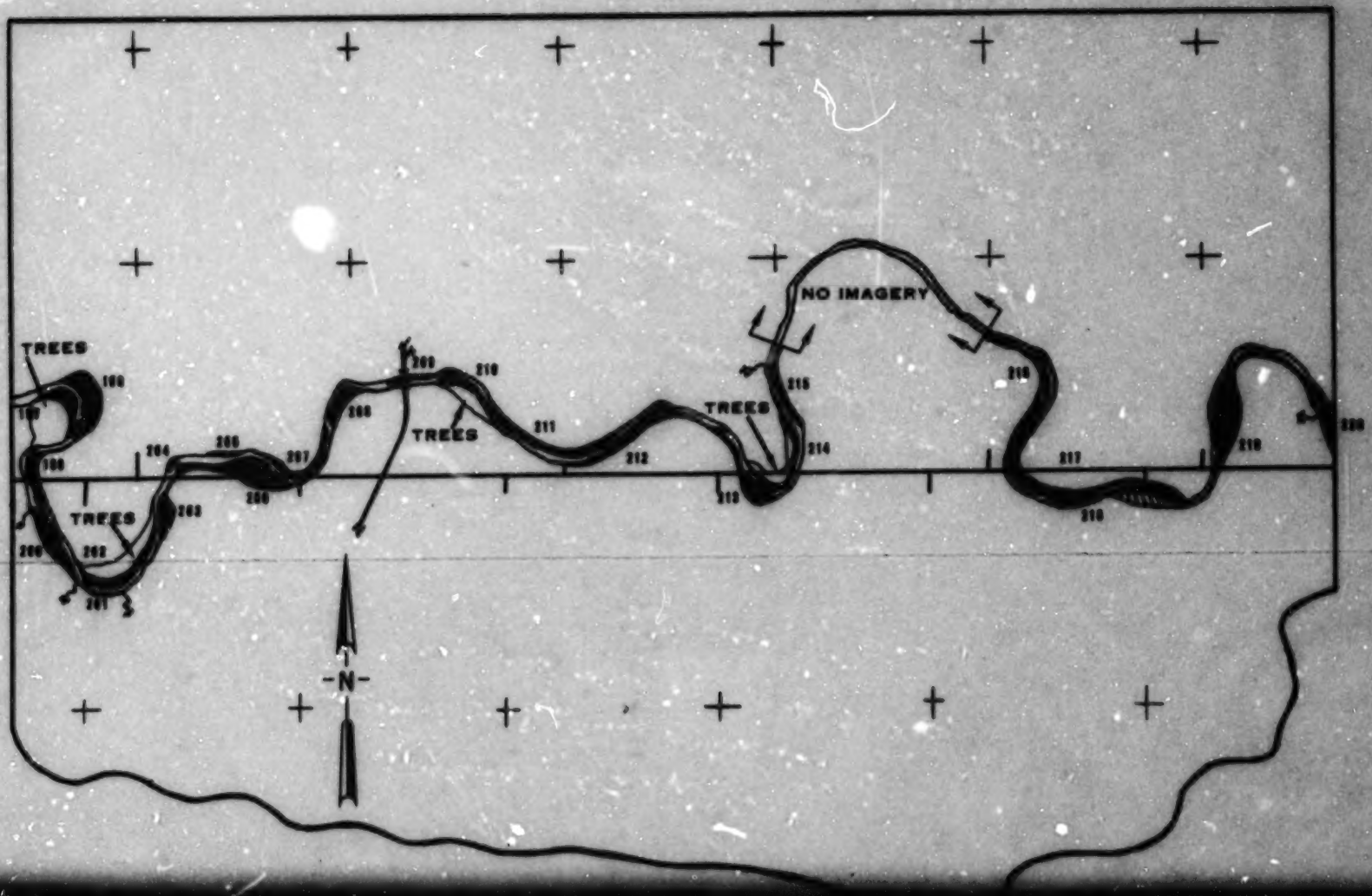


NOTE
SHADED AREAS ARE
TAILING DEPOSITS

33

FIGURE 14 OVERLAY FOR HEREFORD SW, SOUTH DAKOTA 7.5' QUAD MAP
FLIGHTS 20/23 NOVEMBER 1971

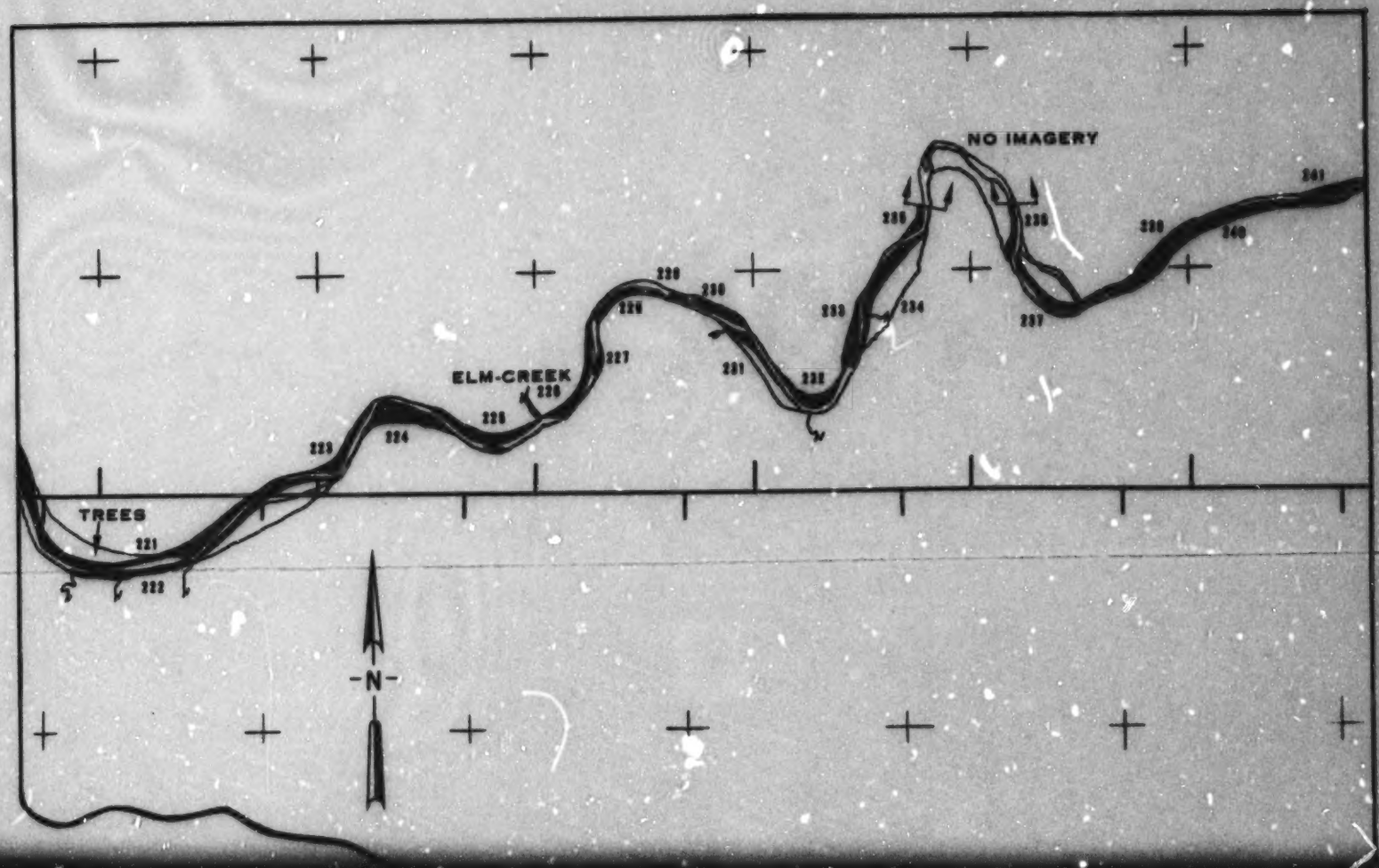
FRAMES 3247-3248-H.A.

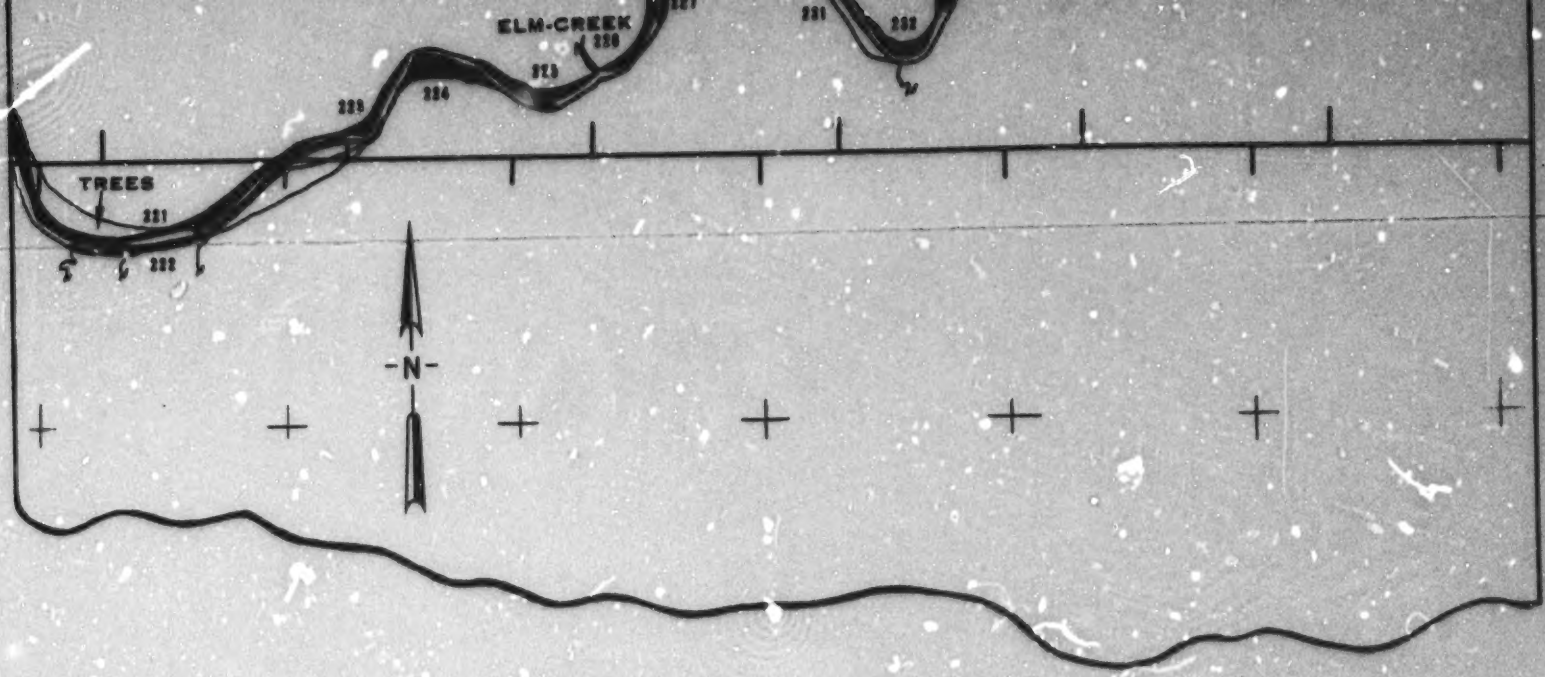

NO IMAGERY
TREES
TREES
TREES
TREES
-N-

NOTE
SHADED AREAS ARE
TAILING DEPOSITS

FIGURE 15 OVERLAY FOR HEREFORD SE.SOUTH DAKOTA 7.5' QUAD MAP
20 NOVEMBER .1971

FRAMES NO.1-2672-2685
NO.2-0604-0618


NO IMAGERY
ELM-CREEK
TREES
-N-
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
241

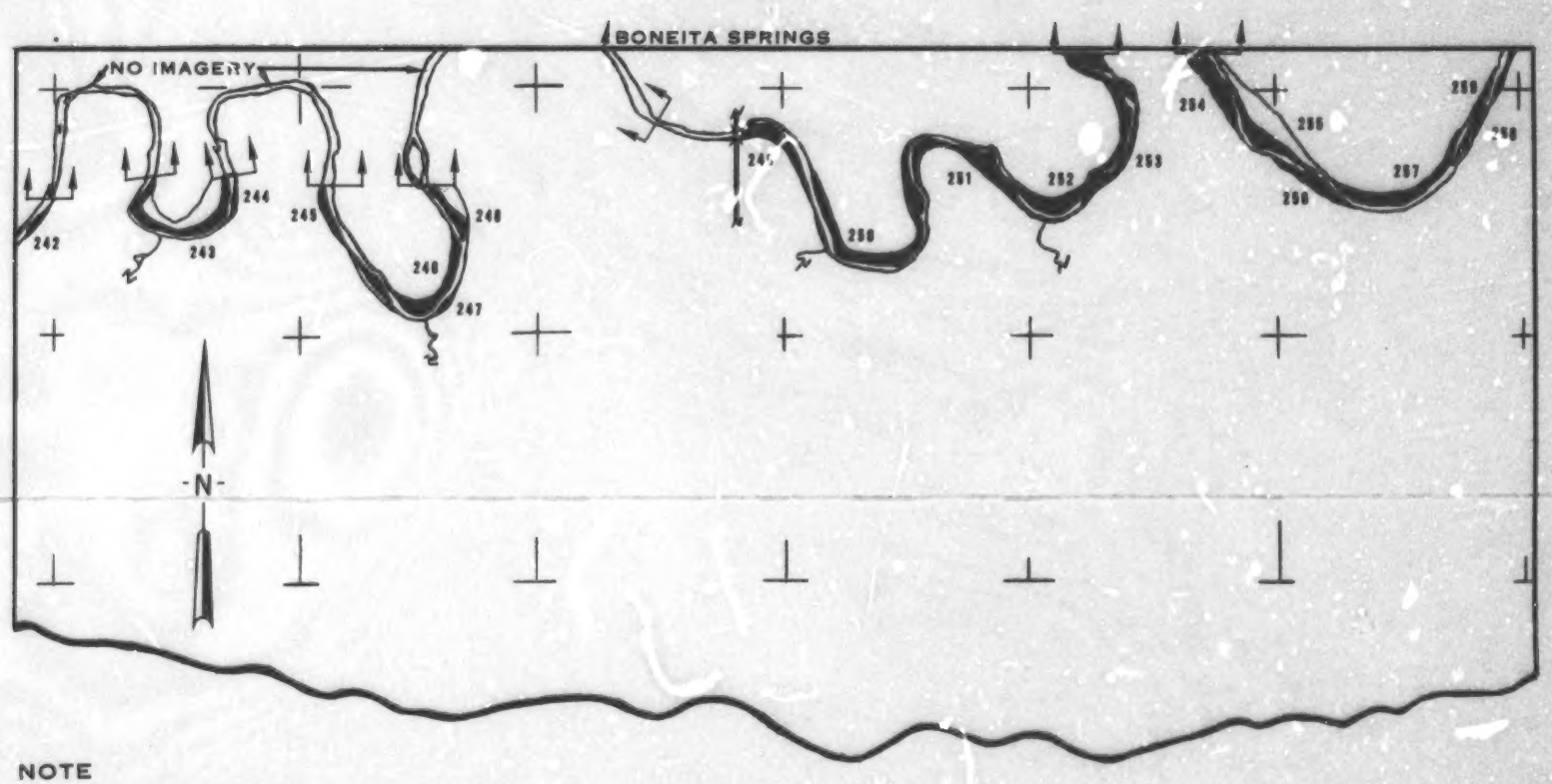


NOTE
SHADED AREAS ARE
TAILING DEPOSITS

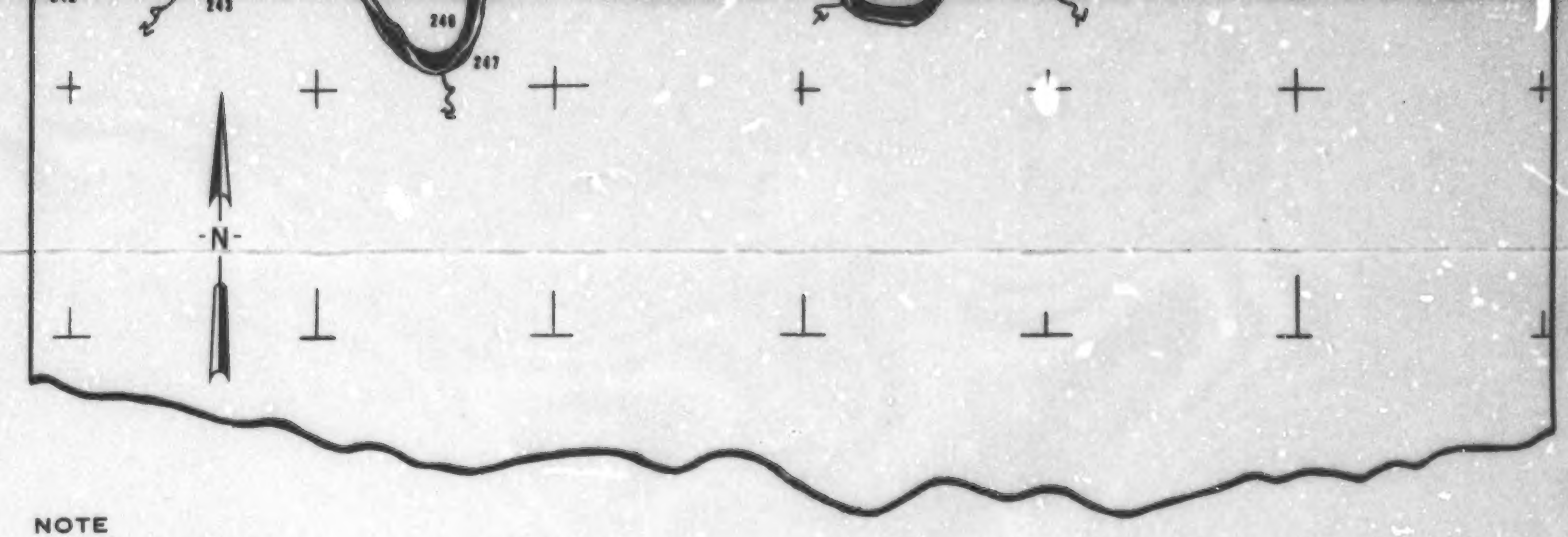
35A

FIGURE 16 OVERLAY FOR ELM SPRINGS SW SOUTH DAKOTA 7.5' QUAD MAP
20 NOVEMBER 1971

FRAMES 2895-2917-LA-1



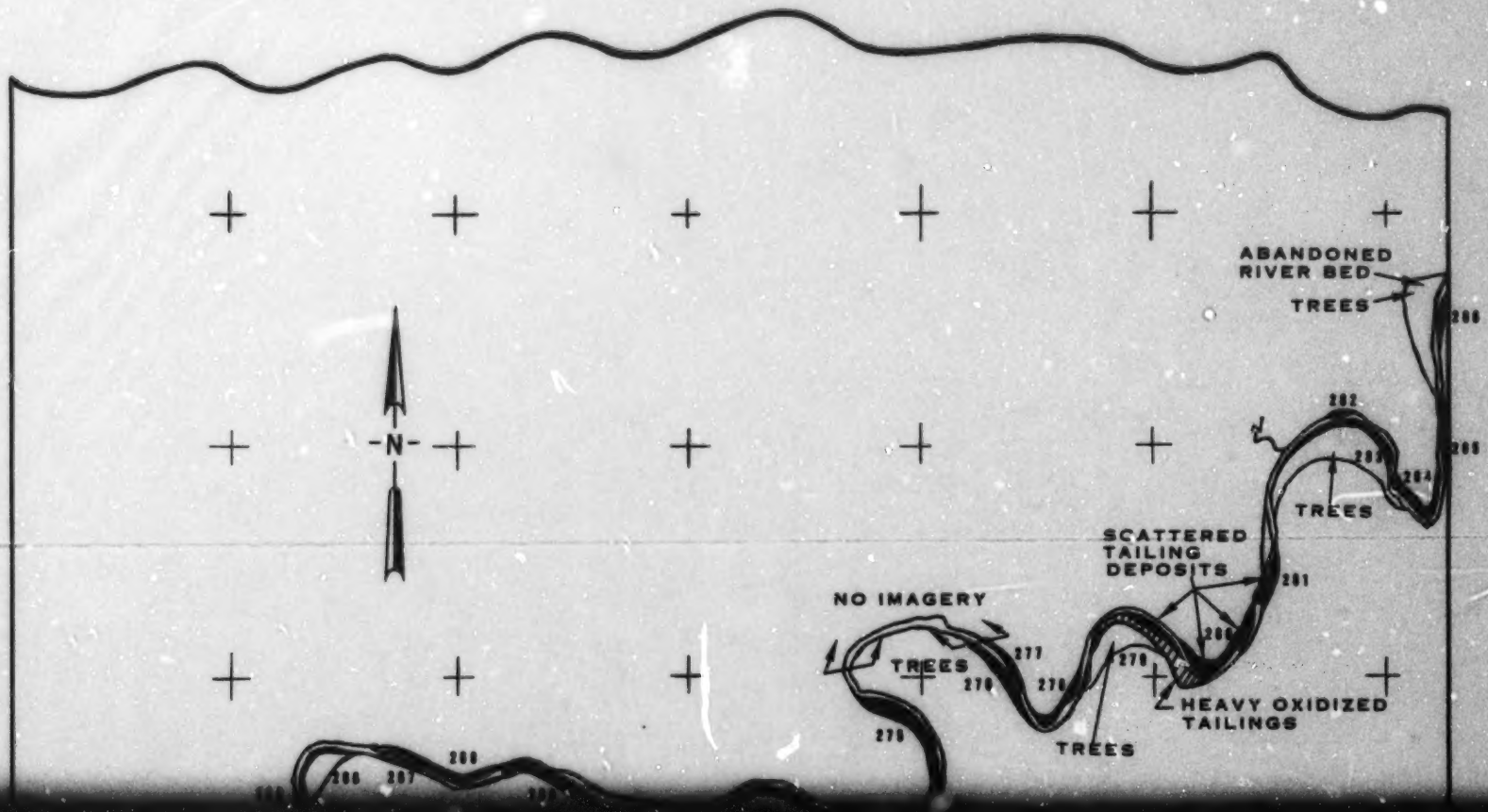
NOTE
SHADED AREAS ARE
TAILING DEPOSITS

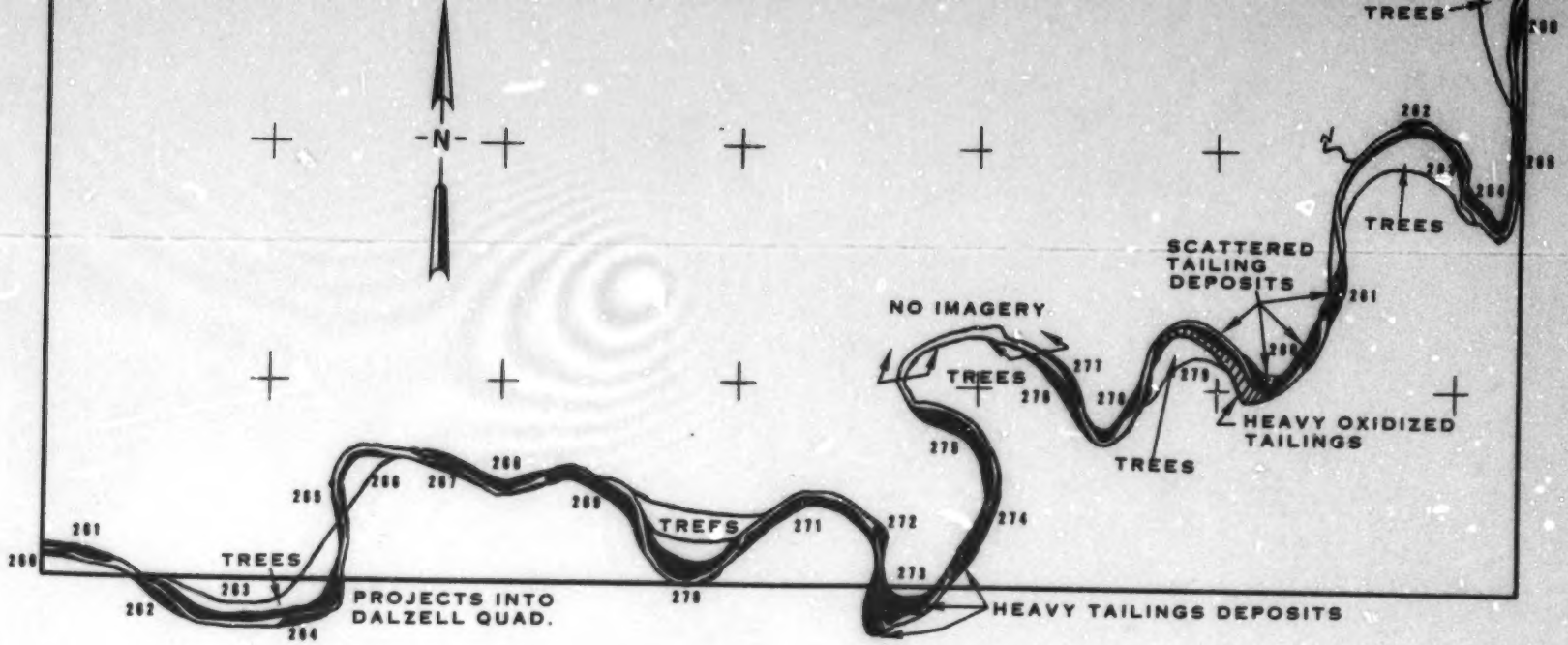


NOTE
SHADED AREAS ARE
TAILING DEPOSITS

FIGURE 17 OVERLAY FOR ELM SPRINGS,SOUTH DAKOTA 7.5' QUAD MAP
20 NOVEMBER,1971

FRAMES 2917-2945-LA-1


ABANDONED
RIVER BED
TREES
286
282
285
284
TREES
SCATTERED
TAILING
DEPOSITS
281
NO IMAGERY
TREES
277
276
278
276
HEAVY OXIDIZED
TAILINGS
275
TREES
-N-
288
286
287

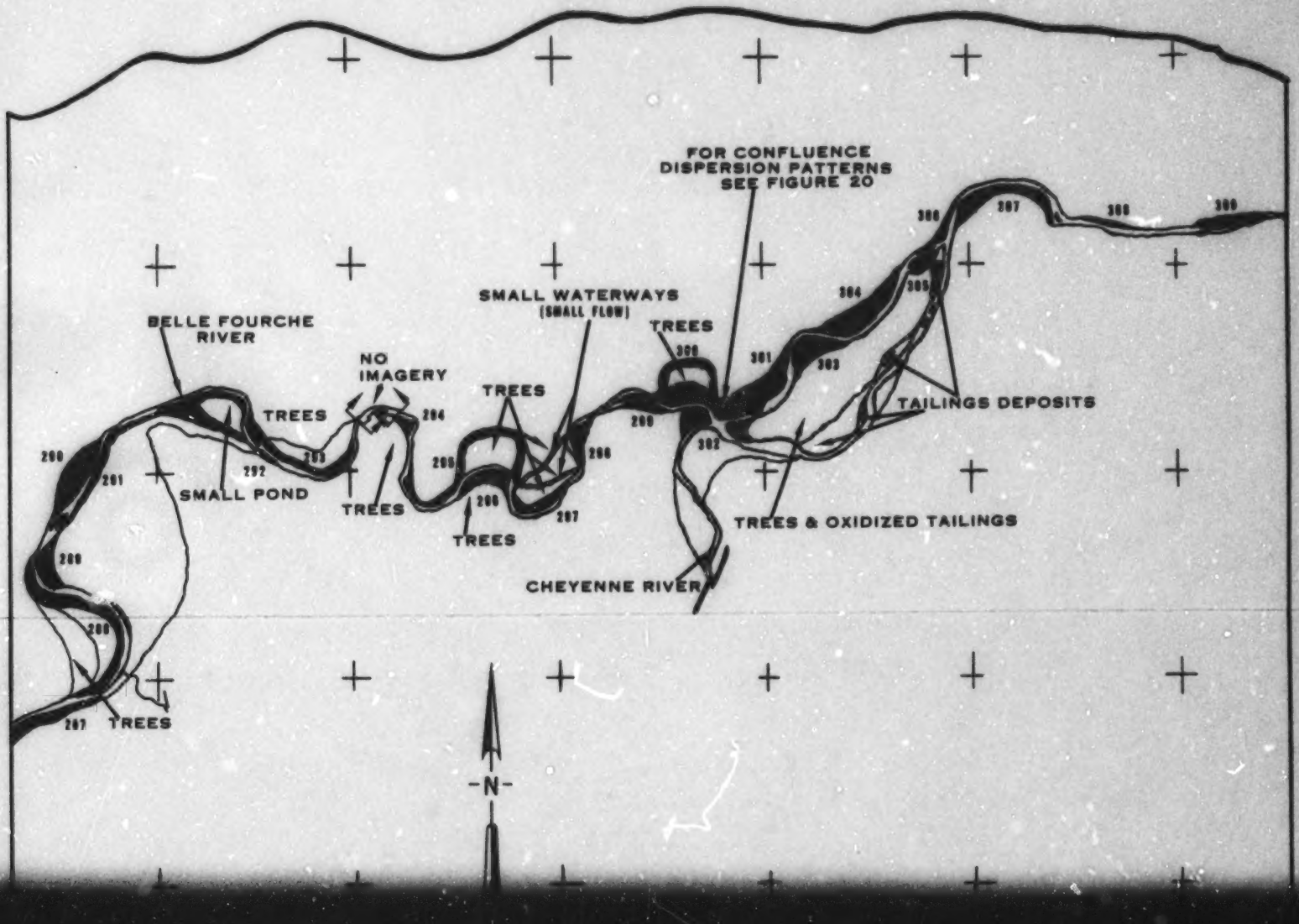


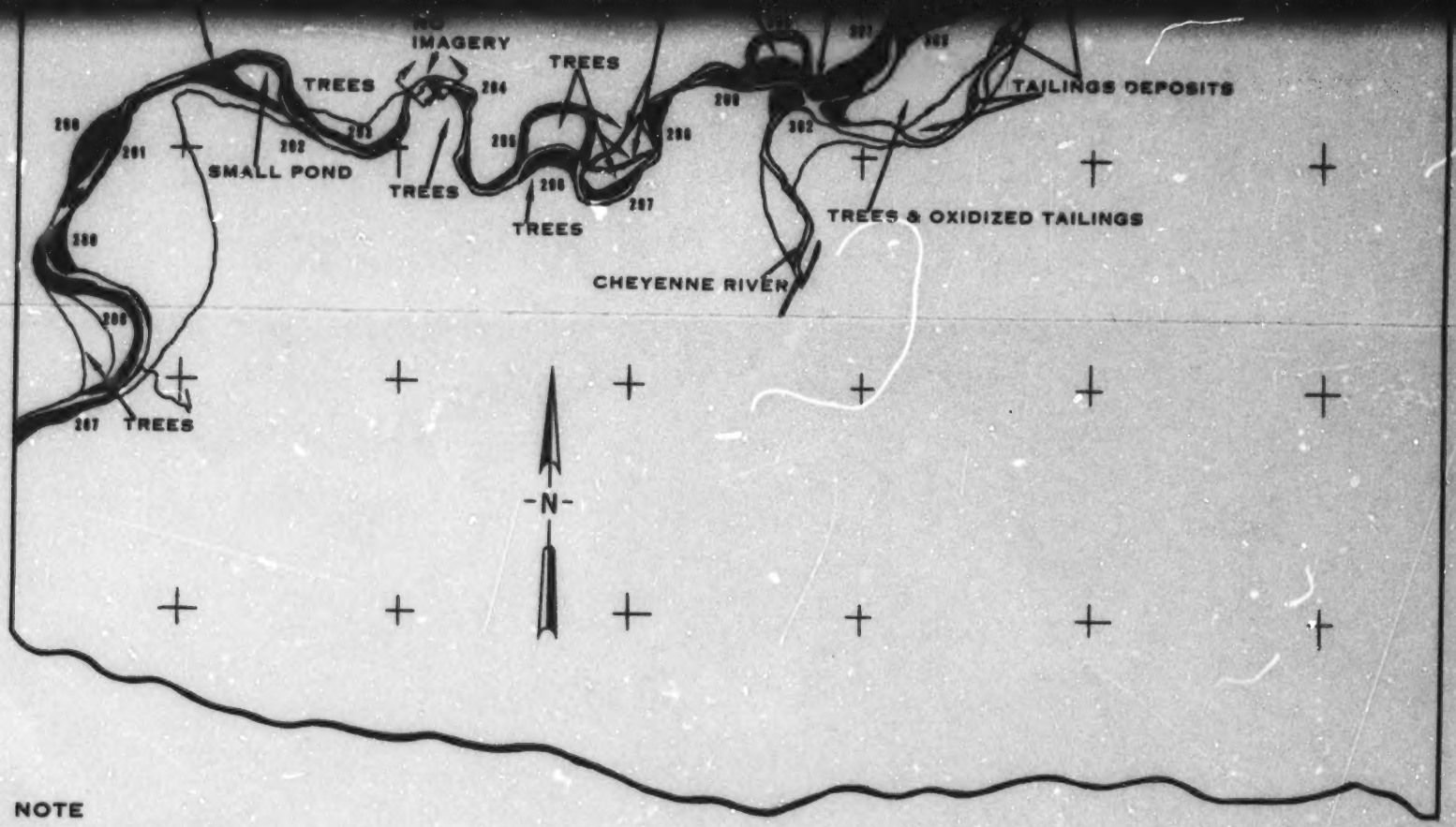
NOTE
SHADED AREAS ARE
TAILING DEPOSITS

36

FIGURE 18 OVERLAY FOR DALZELL N.W.,SOUTH DAKOTA 7.5' QUAD MAP
FLIGHTS 20 NOVEMBER 1971

FRAMES 2945-2970-I.A-1


FOR CONFLUENCE DISPERSION PATTERNS SEE FIGURE 20
SMALL WATERWAYS (SMALL FLOW)
BELLE FOURCHE RIVER
NO IMAGERY
TREES
TREES
TREES
TREES
TREES
TAILINGS DEPOSITS
SMALL POND
TREES
TREES & OXIDIZED TAILINGS
CHEYENNE RIVER
TREES
290
291
292
293
294
295
296
297
298
299
300
301
302
303
304
305
306
307
308
309
N

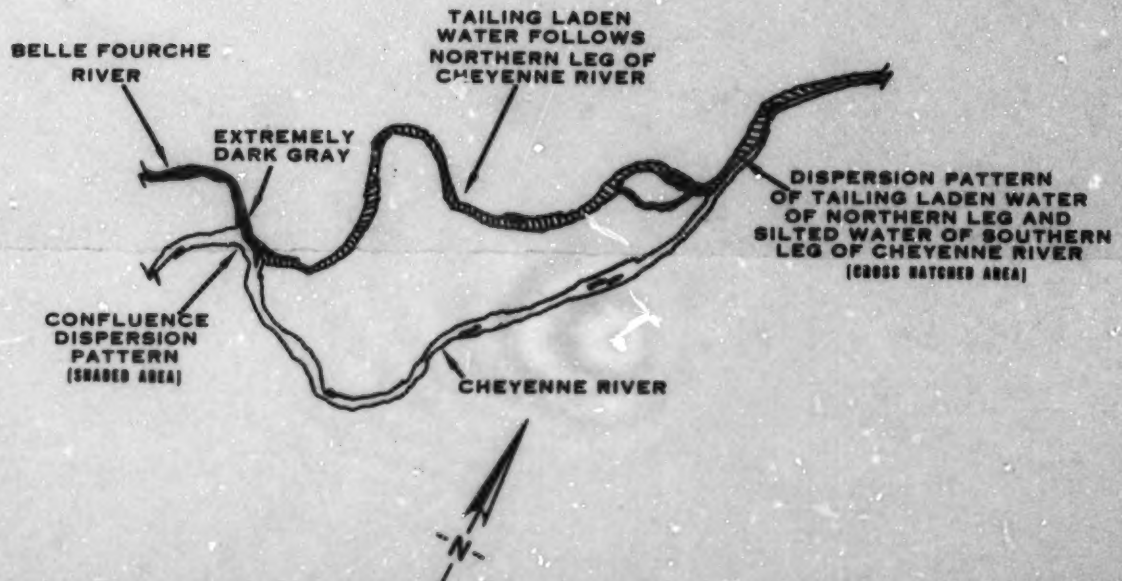


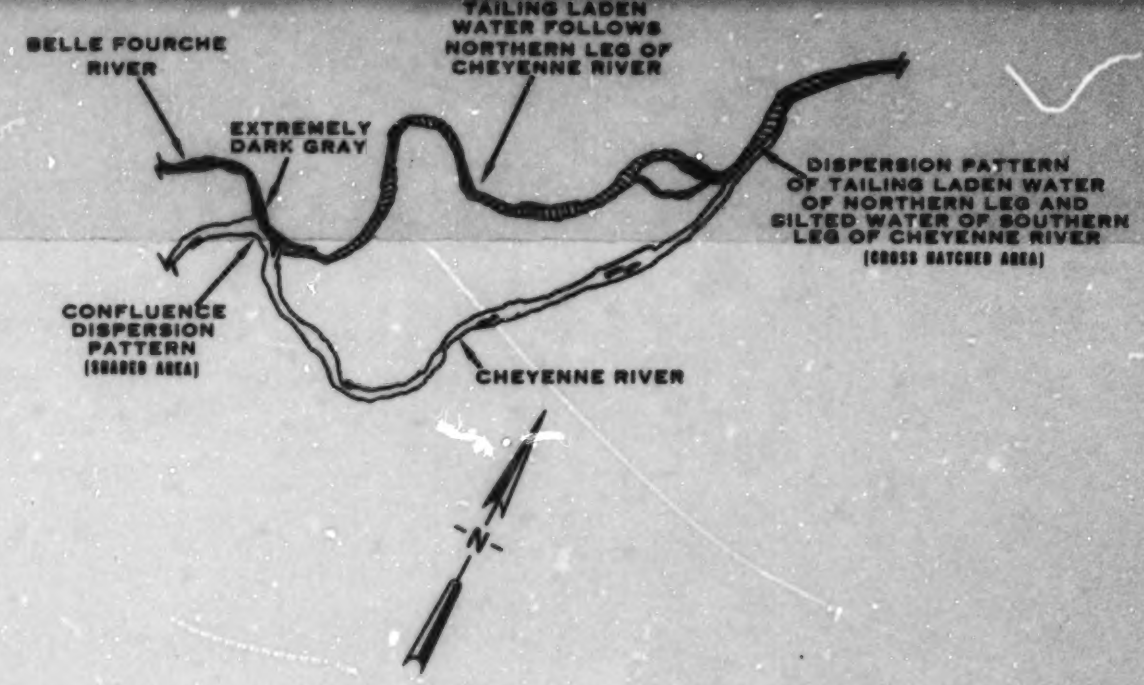
NOTE
SHADED AREAS ARE
TAILING DEPOSITS

37<

FIGURE 19 OVERLAY FOR DALZELL NE.SOUTH DAKOTA 7.5' QUAD MAP
20 NOVEMBER 1971

FRAMES 2971-2993-LA-1


BELLE FOURCHE RIVER
TAILING LADEN WATER FOLLOWS NORTHERN LEG OF CHEYENNE RIVER
EXTREMELY DARK GRAY
DISPERSION PATTERN OF TAILING LADEN WATER OF NORTHERN LEG AND SILTED WATER OF SOUTHERN LEG OF CHEYENNE RIVER
(CROSS HATCHED AREA)
CONFLUENCE DISPERSION PATTERN
(SHADED AREA)
CHEYENNE RIVER
N


BELLE FOURCHE RIVER
TAILING LADEN WATER FOLLOWS NORTHERN LEG OF CHEYENNE RIVER
EXTREMELY DARK GRAY
DISPERSION PATTERN OF TAILING LADEN WATER OF NORTHERN LEG AND SILTED WATER OF SOUTHERN LEG OF CHEYENNE RIVER
(CROSS HATCHED AREA)
CONFLUENCE DISPERSION PATTERN
(SHADED AREA)
CHEYENNE RIVER
N

387

NOTE
SHADED AREAS ARE
TAILING DEPOSITS

FIGURE 20 CONFLUENCE OF BELLE FOURCHE AND CHEYENNE RIVERS
20 NOVEMBER 1971